Appendix G
Seasonal Bird and Bat Survey Reports for the Buckeye Wind Project - Stantec reports

Fall 2007 Bird and Bat Migration Survey Report

Visual, Radar, and Acoustic Bat Surveys for the Buckeye Wind Power Project in Champaign and Logan Counties, Ohio

Prepared for

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Executive Summary

During fall 2007, Stantec, (Stantec), formerly Woodlot Alternatives, Inc. (Woodlot)[1], conducted field surveys of bird and bat migration activity at the proposed Buckeye Wind Energy Project in Champaign and Logan Counties, Ohio (Project). The surveys are part of the planning process by EverPower Renewables (EverPower) for a proposed wind project, which will include erection of a 300 megawatt (MW) wind farm located on mostly open agricultural lands. These surveys represented the first season of investigation undertaken at this site and included diurnal raptor surveys as well as nighttime surveys of birds and bats using radar and bat echolocation detectors. The results of the field surveys provide useful information about site-specific migration activities and patterns in the vicinity of the Buckeye Project, especially when considered along with upcoming spring and summer 2008 surveys.

Nocturnal Radar Survey

The fall 2007 radar survey included 30 nights of sampling from September 1 to October 15, 2007. Surveys were conducted from sunset to sunrise using X-band radar on nights when weather conditions permitted radar operation to adequately document bird movements. Within each hour of sampling, radar video files were recorded while the radar was positioned both horizontally and vertically. The radar site provided an acceptable view of the northern portion of the Project area.

The overall passage rate for the entire survey period was (mean ± standard error [SE]: 74 ± 15 targets/km/hr [t/km/hr]). Nocturnal passage rates were highly variable among nights, ranging from 0 to 404 t/km/hr. The mean flight direction through the Project area was 194º ± 144º (i.e., slightly southwest). The mean flight altitude of targets observed on the radar was 393 meters (m) ± 12 m (1290 feet [ft] ± 39') above ground level (agl). The average nightly flight altitude ranged from 252 m ± 43 m agl (828 ft ± 140 ft) to 506 m ± 27 m agl (1661 ft ± 88 ft). The mean percentage of nocturnal targets observed flying below 125 m agl (410 ft) ranged from 1 to 38 percent by night. The percentage of targets observed flying below 150 m (492 ft) also varied by night, from 2 to 38 percent. The seasonal average for targets flying below 125 m and 150 m was 4 and 5 percent, respectively.

The results of the radar analysis indicate that nocturnally migrating birds and bats in the vicinity of the Project are flying using a broad front migration pattern across the landscape, rather than in a concentrated manner in response to local topography. This is based on the mean flight direction and qualitative analysis of the topography and landscape surrounding the radar location. This type of broad front movement suggests that risk of bird and bat collision with

[1] All field work and any reporting and permitting activities performed prior to October 1, 2007, were conducted as Woodlot Alternatives, Inc. and will be herein referenced as work done by Woodlot. On October 1, 2007, Woodlot Alternatives, Inc. was acquired by Stantec Consulting Services, Inc. Work conducted on or after October 1, 2007, is herein referenced as work done by Stantec.

turbines or their associated infrastructure during migration may be relatively low. Additionally, the mean flight altitude of targets indicates that the majority of nocturnal migration in the area occurred well above the maximum altitude of the proposed wind turbines.

Fall Acoustic Bat Survey

The fall 2007 acoustic bat survey documented bat activity using six Anabat detectors during passive surveys that occurred on 63 nights from August 28 to October 29, 2007. The operation period of individual detectors ranged from a maximum of 57 nights to a minimum of 11 nights, for a total survey of 226 detector nights. Three detectors were deployed at three altitudes (high, low, and at tree level) at each of two meteorological (met) towers in the Project area, for a total of six detectors. The majority of the recorded bat call sequences (48%) were identified as unknown, followed by those identified to the big brown guild (34% of all call sequences), the red bat/eastern pipistrelle guild (18% of all call sequences), and the *Myotis* guild (< 1%). Throughout the migration season, bat activity was highest during the 10:00 pm hour (16% of all calls were recorded during this hour) and declined thereafter.

The mean number of bat calls/detector night for all six Anabat detectors deployed across the Project area was 7.54. Of the six detectors, the south tree detector recorded the highest number of bat call sequences (681) during the 24 days of operation, with a detection rate of 28.38 total calls/detector night. The north low detector followed with 57 nights of operation, 275 bat passes and a detection rate of 4.82 total calls/detector night. The south high detector operated for 57 nights, recorded 222 bat passes with a detection rate of 3.89 total calls/detector night. The north high detector operated for 52 nights, recorded 176 bat call sequences and had an overall detection rate of 3.38 bat passes/detector night. The north tree detector (88 total calls or 3.52 calls/ detector night) and the south low detector (80 total calls or 7.27 calls/ detector night) collected the least number of bat calls, but only operated for 25 and 11 nights respectively.

Raptor Migration Survey

Eleven days of diurnal raptor surveys were conducted from August 30 to October 11, 2007 to document the species migrating through the Project area, as well as behavioral characteristics such as flight altitude and direction relative to the Project area. Surveys were conducted on an open hillside in the central portion of the Project area near a communication tower, which provided a reference for determining raptor flight altitudes. A total of 421 individual raptors were observed during diurnal surveys, representing eight species. No federally threatened or endangered species were observed during the survey period. Three species listed by the Ohio Department of Natural Resources were observed however; two northern harriers (*Circus cyaneus*), listed as endangered, were observed in October; one sharp-shinned hawk (*Accipiter striatus*), listed as a species of concern, was observed in September; and three black vultures (*Coragyps atratus*), also listed as a species of concern, were detected in September and October.

The majority (n = 380; 90%) of raptors observed during the survey period were turkey vultures (*Carthartes aura*). Red-tailed hawks (*Buteo jamaicensis*) represented 3 percent of all observations (n = 14) and were the second most abundant species observed during the survey. The majority of observed raptors were flying below 125 m and 150 m. However, migrating raptor numbers were relatively low, and raptors do not appear to concentrate within the Project area. Thus, impacts to raptor populations migrating through the Project area are not expected to be adverse.

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PN195600164/WAI# 107239

1.0 Introduction

This report has been prepared to summarize results of fall 2007 avian and bat surveys conducted by Woodlot Alternatives, Inc. (Woodlot), now Stantec Consulting (Stantec)[2], within the proposed Buckeye Wind Energy Project (Project) area. Following is a brief description of the Project; a review of the methods used to conduct scientific surveys and the results of those surveys; a discussion of those results; and the conclusions reached based on those results.

1.1 PROJECT CONTEXT

EverPower Renewables (EverPower) has proposed to develop a 300 MW wind power facility in central Ohio, in Champaign and Logan counties. The facility would include construction of turbine towers and pads, transmission lines, and access roads. The Project will be located on approximately 53,760 acres (84 square miles; mi^2) of privately owned, predominantly agricultural lands near the towns of Mutual, Mechanicsburg, Mingo, Woodstock, and North Lewisburg. The Project is still in the preliminary stages of design, but is expected to consist of 120 turbines, three meteorological (met) towers and associated access roads, transmission lines, and an electrical substation. The turbines will likely be 2 MW machines mounted on tubular steel towers. The height specifications of proposed turbines have not yet been determined, but turbines could range from a maximum height of either 125 meter (m; 410 feet [ft]; 80 m hub height with 45 m blade length), to a maximum of 150 m (492 ft; 100 m hub height with 50 m blade length).

In advance of permitting activities for the Project, EverPower contracted Stantec to conduct a nocturnal radar survey, a raptor migration survey, and a bat acoustic echolocation detector survey. These surveys will provide data to help assess the potential impacts to birds and bats from the proposed Project. The scope of avian and bat surveys reported herein was based on standard pre-construction survey methods that have been developed by stakeholders within the wind power industry, as well as guidelines developed by the Ohio Department of Natural Resources (OH DNR) and the Reynoldsburg Ohio Ecological Services Field Office of the Unites States Fish and Wildlife Service (OH USFWS). The protocol used to conduct fall 2007 avian and bat surveys for this Project are consistent with the survey protocols approved for several other wind energy projects conducted recently in Pennsylvania, New York, and other states within the Northeast region of the United States.

This document, and all field surveys conducted in support of this document, are in accordance with the work plan developed by Stantec on November 27, 2007. Meetings were held between Stantec, EverPower, OH DNR, and OH USFWS on October 3 and November 28 , 2007, to

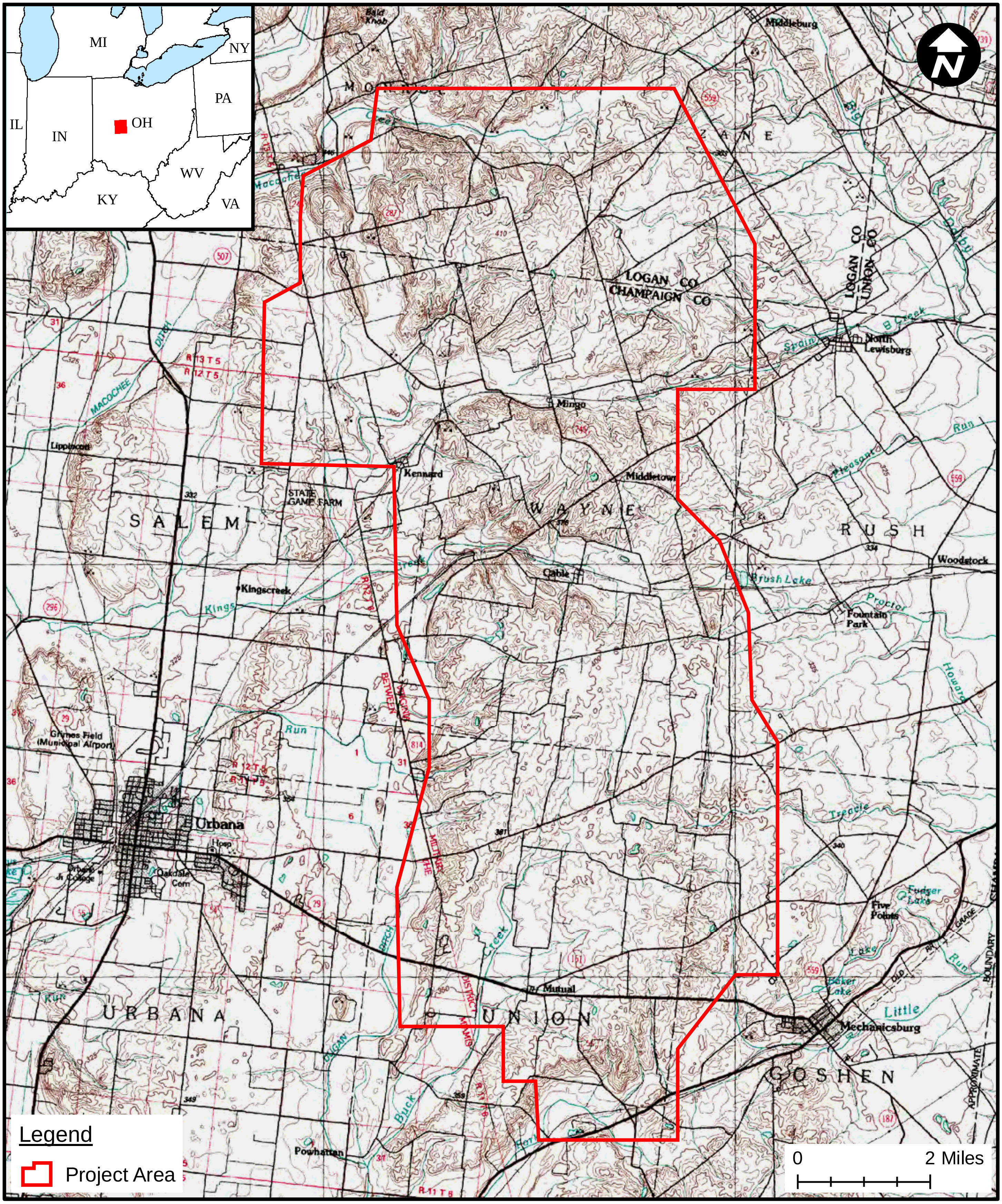
[2] All field work and any reporting and permitting activities performed prior to October 1, 2007, were conducted as Woodlot Alternatives, Inc. and will be herein referenced as work done by Woodlot. On October 1, 2007, Woodlot Alternatives, Inc. was acquired by Stantec Consulting Services, Inc. Work conducted on or after October 1, 2007, is herein referenced as work done by Stantec.

review the work plan and receive any agency comments to be incorporated into future work. A final work plan for avian and bat surveys is expected to be approved in the winter of 2008 that will be the result of this collaborative process.

1.2 PROJECT AREA DESCRIPTION

The Project area is a mosaic of active agricultural lands, mostly corn and soybean, interspersed with stands of mixed hardwood forest. The geology of the Project area is dominated by karst topography with subterranean drainages, sinkholes, and small rolling hills. It lies on an approximately 396 m (1,300 ft) plateau that rises 91 to 152 m (300 to 500 ft) from the surrounding landscape. The northern portion of the Project area has more karst topography features and a greater density of woodlots bordering agricultural fields than the southern sections. Land use in the area involves active agricultural operations, low density residential developments, and some tourist activity at historical sites.

The area is comprised of predominantly agricultural habitat, with scattered areas of upland and riparian forests, as well as shrub habitats. Forested habitat that supports water features such as streams comprises only 4,052 acres (6.31 mi^2) or 7 percent of the total Project area. Turbines are proposed to be located on hilltops, most of which consist of open agricultural lands. Forest stands surrounding these large agricultural areas are structurally diverse; containing large shagbark hickories (*Carya ovata*), ash (*Fraxinus* spp.), and oaks (*Quercus* spp.) intermixed with younger hardwood stands. These stands contain both live and dead trees and likely provide habitat for a variety of bird and bat species (Figure 1-1).



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107239-F11-ProjectLocation.mxd

Sheet Title:

Project Location Map

Project:

Buckeye Wind Power Project, Ohio

Date: 12/17/2007

Scale: 1" = 2 Miles

Proj. No.: 107239

Figure:

1-1

1.3 SURVEY OVERVIEW

Woodlot conducted field investigations, or surveys, for bird and bat migration during fall 2007. The overall goals of the investigations were to document:

- passage rates for nocturnal migration in the vicinity of the Project area, including the number of migrants, their flight direction, and their flight altitude;
- activity patterns of bats in the Project area, including the rate of occurrence and relationship with weather factors;
- species composition of bats within the Project area, and where possible, the presence of any rare, threatened, or endangered species; and
- passage rates and species composition of raptors migrating through the Project area.

The following sections outline the survey methodology and results contributing toward the achievement of survey goals. Discussion of survey results and subsequent conclusions follow each section.

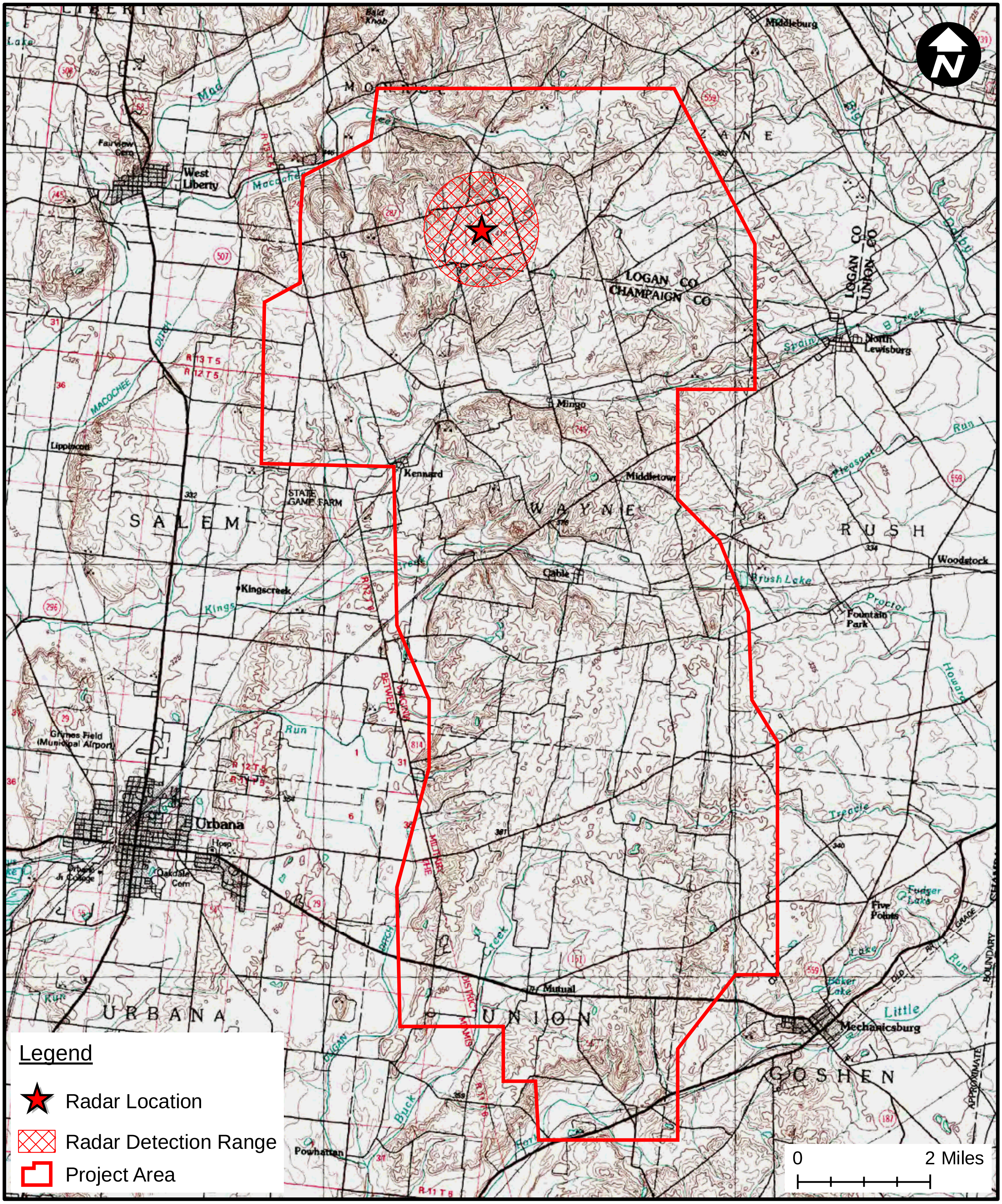
2.0 Nocturnal Radar Survey

2.1 INTRODUCTION

The majority of North American passerines migrate at night. The strategy to migrate at night may have evolved to take advantage of more stable atmospheric conditions for flapping flight (Kerlinger 1995). Additionally, night migration may provide a more efficient medium to regulate body temperature during active, flapping flight and could reduce the potential for predation while in flight (Alerstam 1990, Kerlinger 1995). Conversely, species, such as raptors, that use soaring flight migrate during the day to take advantage of warm rising air in thermals and laminar flow of air over the landscape, which can create updrafts along hillsides and ridgelines. Whereas raptor migration can be documented by visual daytime surveys, documenting the patterns of nocturnally migrating birds requires the use of radar or other non-visual technologies. Nocturnal radar surveys were conducted in the Project area to characterize fall nocturnal migration patterns. The goal of the surveys was to document the overall passage rates for nocturnal migration in the vicinity of the Project area, including the number of migrants, their flight direction, and their flight altitude.

2.2 METHODS

The radar survey was conducted near the northern met tower along the edge of a small valley (Figure 2-1). This site provided the best views in the northern section of the Project area and was chosen in order to intercept as much of the broad front movement of south bound migrants as possible. The site was at an elevation of approximately 418 m (1370 ft) and provided a generally good view in all directions.



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Sheet Title:

Radar Location Map

Project:

Buckeye Wind Power Project, Ohio

Date:	12/17/2007
Scale:	1" = 2 Miles
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The radar was placed at an altitude of approximately 4.2 m (14 ft) above the ground in a clearing adjacent to a small willow (*Salix* spp.) hedgerow, within a larger agricultural field opening. This opening was in a slight depression between two hills crested with hedgerows. These adjacent hills provided topographic relief that masked out the lower portion of the radar beam and allowed for less ground clutter and greater detection of small targets flying near or at tree line throughout the entire radar coverage area (Figure 2-2).

Marine surveillance radar, similar to that described by Cooper *et al.* (1991), was used during field data collection. The radar has a peak power output of 12 kilowatts (kW) and has the ability to track small animals, including birds, bats, and even insects, based on settings selected for the radar functions. It cannot, however, readily distinguish between different types of animals being detected. Consequently, all animals observed on the radar screen were identified as “targets.” The radar has an “echo trail” function which captures past echoes of flight trails, enabling determination of flight direction. During all operations, the radar’s echo trail was set to 30 seconds. The radar was equipped with a 2 m (6.5 ft) waveguide antenna. The antenna has a vertical beam altitude of 20º (10º above and below horizontal), and the front end of the antenna was inclined approximately 5º to increase the proportion of the beam directed into the sky.

Objects on the ground detected by the radar cause returns on the radar screen (echoes) that appear as blotches called ground clutter. Large amounts of ground clutter reduce the ability of the radar to track birds and bats flying over those areas. However, vegetation and hilltops near the radar can be used to reduce or eliminate ground clutter by “hiding” clutter-causing objects from the radar. These nearby features also cause ground clutter, but their proximity to the radar antenna generally limits the ground clutter to the center of the radar screen (Figure 2-2). The presence or reduction of potential clutter producing objects was carefully considered during site selection and radar station configuration.

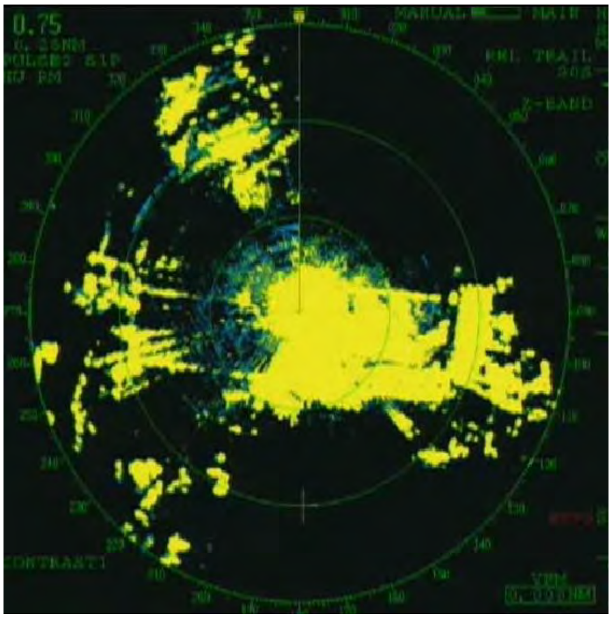


Figure 2-2. Ground clutter at Buckeye Wind Project- Fall 2007

Radar surveys were conducted from sunset to sunrise for 30 nights between September 1 and October 15, 2007. Because the anti-rain function of the radar must be turned down to detect small songbirds and bats, surveys could not be conducted during periods of inclement weather. Therefore, surveys were planned largely for nights without rain. However, in order to characterize migration patterns during nights without optimal conditions, some nights with weather forecasts including occasional showers were sampled.

The radar was operated in two modes throughout the night. In surveillance mode, the antenna spins horizontally to survey the airspace around the radar and detects targets moving through the area. By analyzing the echo trail, the flight direction of targets can be determined. In vertical mode, the radar unit is tilted 90º to vertically survey the airspace above the radar (Harmata *et al.* 1999). In vertical mode, target echoes do not provide directional data, but do provide information on the altitude of targets passing through the vertical, 20º radar beam. Both modes of operation were used during each hour of sampling.

The radar was operated at a range of 1.4 km (0.75 nautical miles). At this range, the echoes of small birds can be easily detected, observed, and tracked. At greater ranges, larger birds can be detected, but the echoes of small birds are reduced in size and restricted to a smaller portion of the radar screen, thus limiting the ability to observe the movement pattern of individual targets.

2.2.1 Data Collection

The radar display was connected to the video recording software of a computer enabling digital archiving of the radar data for subsequent analysis. Approximately 25 minutes of video samples were recorded during each hour of radar surveys, based on a random schedule for each night. These included 15 one-minute horizontal samples and 10 one-minute vertical samples. This sampling schedule allowed for randomization of sample collection and prevented double-counting of targets due to the 30-second echo trail used to determine the flight path vector.

During each hour, additional information was also recorded, including weather conditions and ceilometer observations. Ceilometer observations involved directing a one-million candlepower spotlight vertically into the sky in a manner similar to that described by Gauthreaux (1969). The ceilometer beam was observed by eye for 5 minutes to document and characterize low-flying targets. The ceilometer was held in-hand so that any birds, bats, or insects passing through it could be tracked for several seconds, if needed; surveys were conducted from the radar survey site. Observations from each ceilometer observation period were recorded, including the number of birds, bats, and insects observed. This information was used during data analysis to help characterize activity of insects, birds, and bats.

2.2.2 Data Analysis

Video samples were analyzed using a digital analysis software tool developed by Woodlot. For horizontal samples, targets (either birds or bats) were differentiated from insects based on their flight speed. Following adjustment for wind speed and direction, targets traveling faster than approximately 6 m (20 ft) per second were identified as a bird or bat target (Larkin 1991, Bruderer and Boldt 2001). The software tool recorded the time, location, and flight vector for each target traveling fast enough to be a bird or bat within each horizontal sample, and these results were output to a spreadsheet. For vertical samples, the software tool recorded the entry point of targets passing through the vertical radar beam, the time, and flight altitude above the radar location, and then subsequently outputs the data to a spreadsheet. These datasets were then used to calculate passage rate (reported as targets per kilometer of migratory front per hour), flight direction, and flight altitude of targets.

Mean target flight directions (± 1 circular standard deviation) were summarized using software designed specifically to analyze directional data (Oriana2© Kovach Computing Services). The statistics used for this analysis are based on those used by Batschelet (1965) because they take into account the circular nature of the data. Nightly wind direction was also summarized using similar methods and data, which was collected from the nearest met tower to the radar.

Flight altitude data were summarized using linear statistics. Mean flight altitudes (± 1 standard error [SE]) were calculated by hour, night, and overall season. The percentages of targets flying below 125 m and 150 m, the potential range of maximum turbine height, were also calculated hourly, nightly, and for the entire survey period.

2.3 RESULTS

Radar surveys were conducted during 30 nights between September 1 and October 15, 2007 (Appendix A, Table 1).

2.3.1 Passage Rates

The overall passage rate for the entire survey period was (mean ± SE; 74 ± 15 targets/kilometer/hour [t/km/hr]). Nightly passage rates varied from 0 ± 0 t/km/hr on October 10 to 404 ± 64 t/km/hr on September 10 (Figure 2-3; also Appendix A, Table 1). Individual hourly passage rates varied from 0 to 675 t/km/hr (Appendix A, Table 1). For the entire season, passage rates were highest during the first three hours after sunset and then decreased steeply thereafter (Figure 2-4). Mean nightly wind speeds varied from 2.3 to 8.0 meters/second (m/s) throughout the season, while mean nightly temperature ranged from 4.8 to 23.9 Celsius (41 to 75 º F). There was no correlation between wind speed and passage rate (n=30, r = -0.06, p=0.76) and a low correlation between temperature and passage rate (n=30, r=0.58, p=<0.01).

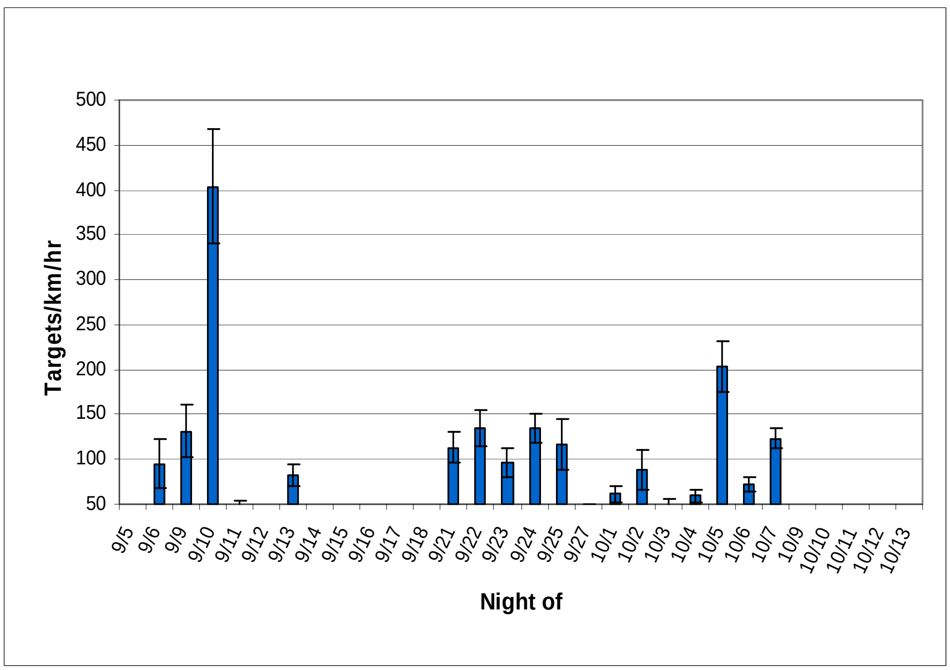


Figure 2-3. Nightly passage rates observed (error bars ± 1 SE) at Buckeye Wind Project, fall 2007

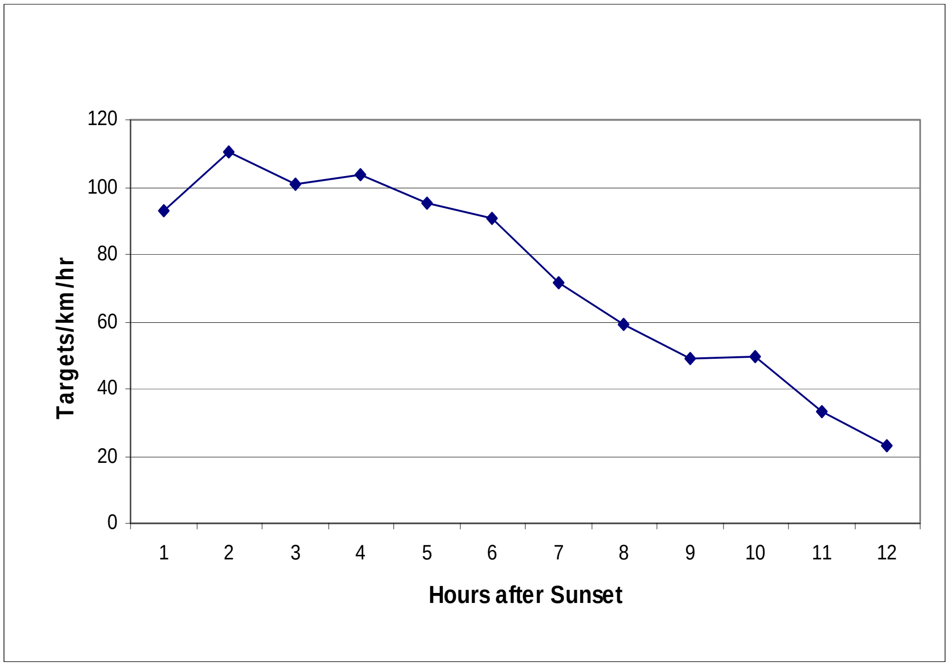


Figure 2-4. Hourly passage rates for entire season at Buckeye Wind Project, fall 2007

2.3.2 Flight Direction

Mean flight direction through the Project area was (mean ± circular standard deviation) 194° ± 144° (Figure 2-5). There was significant directional variation between nights (Appendix A, Table 2).

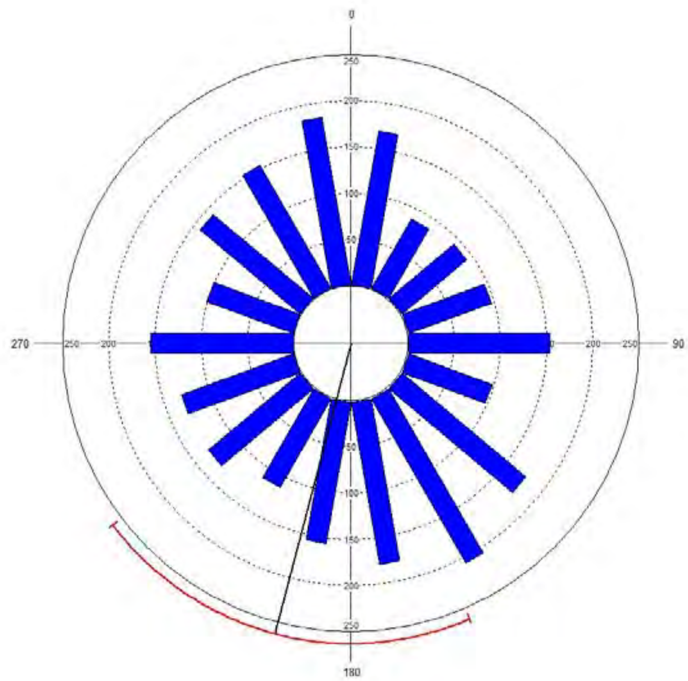


Figure 2-5. Mean flight direction for the entire season (the bracket along the margin of the histogram is the 95% confidence interval) at Buckeye Wind Project, fall 2007

2.3.3 Flight Altitude

The seasonal average mean flight altitude of targets was 393 m ± 12 m (1290 ft ± 39 ft) above the radar site. The average nightly flight altitude ranged from 252 m ± 43 m (828 ft ± 140 ft) on October 10 to 506 m ± 27 m (1661 ft ± 88 ft) on September 5 (Figure 2-6; Appendix A, Table 3). The percent of targets observed flying below 125 m (410 ft) also varied by night, from 1 percent to 38 percent. The seasonal average percentage of targets flying below 125 m was 4 percent (Figure 2-7). The percent of targets observed flying below 150 m (492 ft) also varied by night, from 2 percent to 38 percent. The seasonal average percentage of targets flying below 150 m was 6 percent (Figure 2-8). Hourly flight altitude was consistent throughout the night (Figure 2-8).

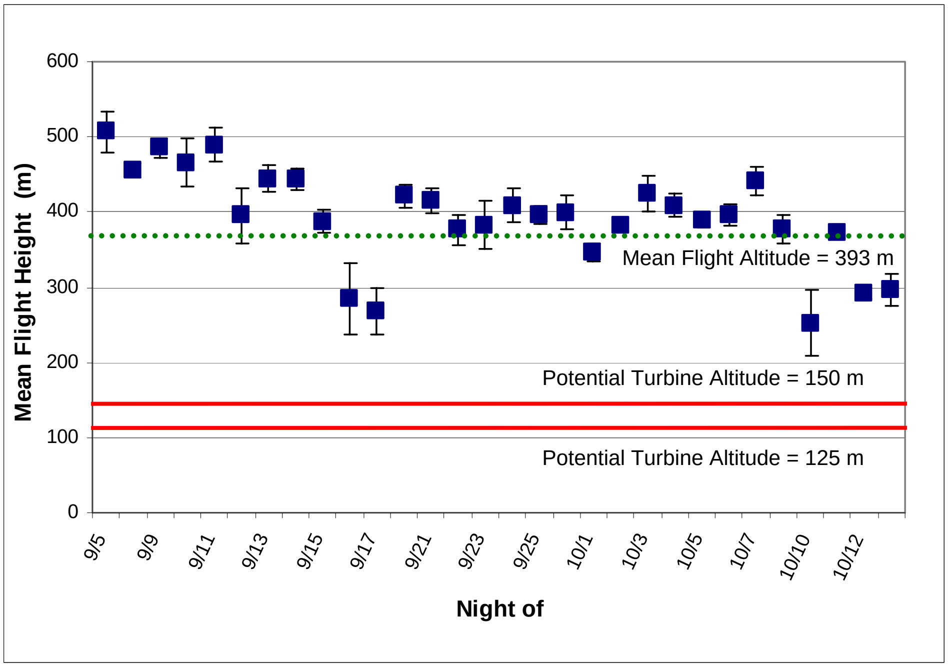


Figure 2-6. Mean nightly flight altitude of targets (error bars ± 1 SE) at Buckeye Wind Project - Fall 2007

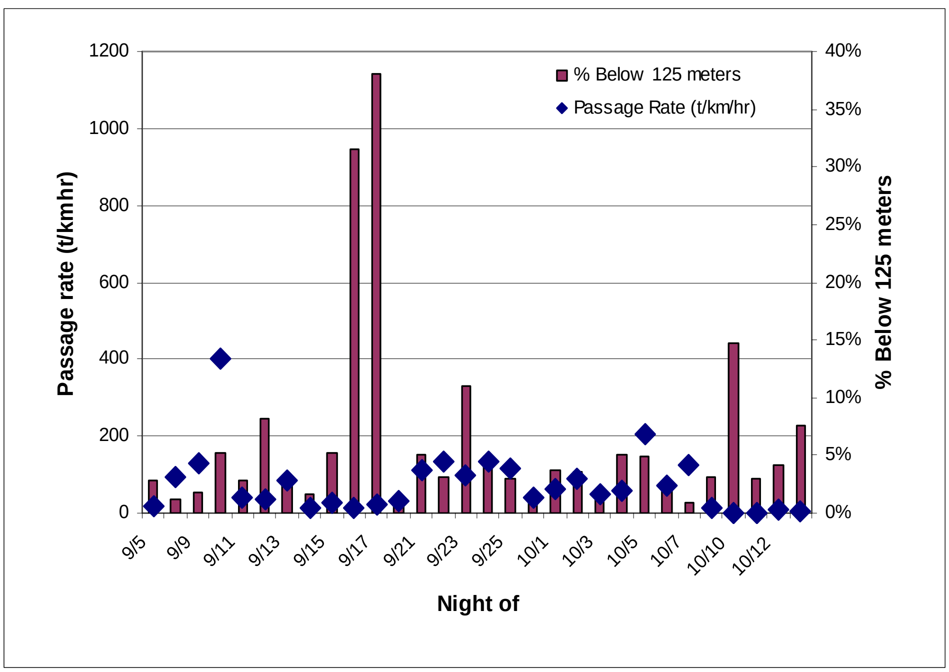


Figure 2-7. Percent of targets observed flying below an altitude of 125 m (410 ft) at Buckeye Wind Project, fall 2007

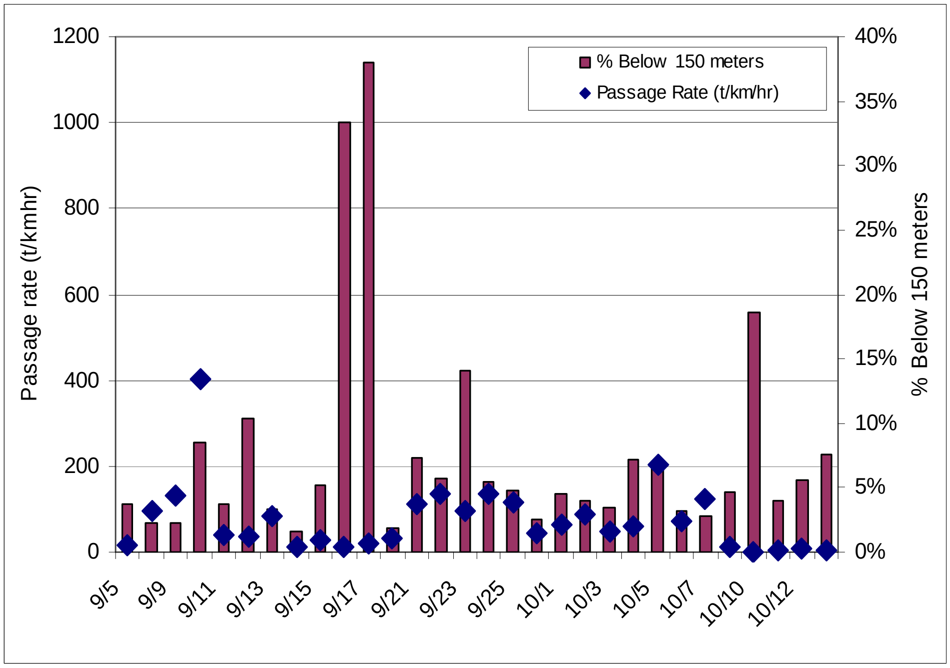


Figure 2-8. Percent of targets observed flying below an altitude of 150 m (492 ft) at Buckeye Wind Project, fall 2007

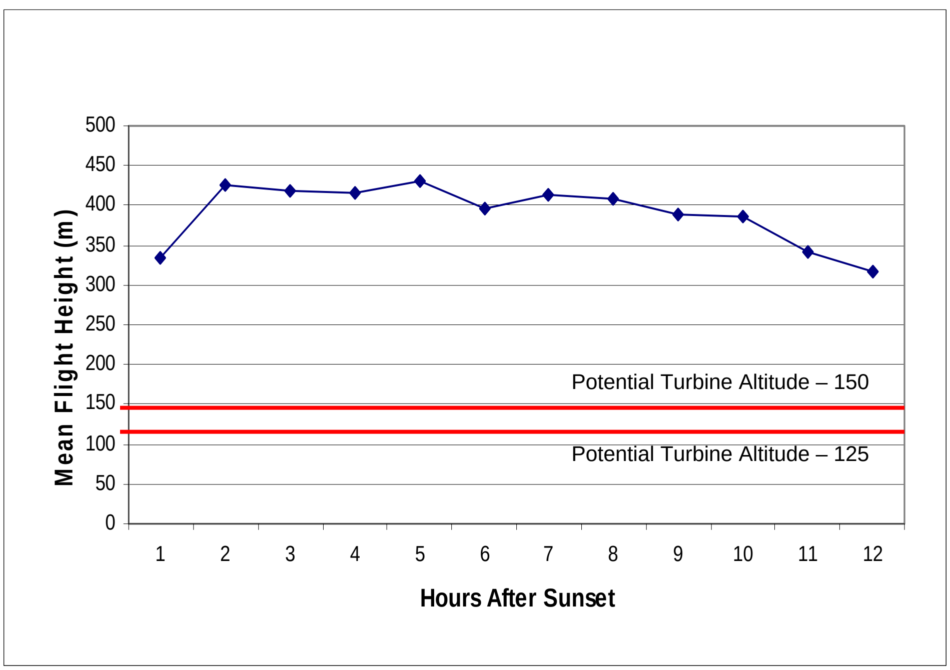


Figure 2-9. Hourly target flight altitude distribution at Buckeye Wind Project, fall 2007

2.3.4 Ceilometer Observations

Ceilometer data collected during the radar survey yielded a total of 277 5-minute observations, which included no birds and one bat in the ceilometer beam.

2.4 DISCUSSION

Nightly variation in the magnitude and flight characteristics of nocturnal migrants is not uncommon and is often attributed to weather patterns, such as cold fronts and winds aloft (Hassler *et al.* 1963, Gauthreaux and Able 1970, Richardson 1972, Able 1973, Bingman *et al.* 1982, Gauthreaux 1991). Data from regional surveys using similar methods and equipment conducted within the last several years are rapidly becoming available and provide an opportunity to compare the results from other wind projects. There are limitations in comparing data from previous years with data from 2007, as year-to-year variation in continental bird populations may influence how many birds migrate through an area. Additionally, differing site characteristics such as topography, local landscape conditions, and vegetation surrounding a radar survey location can play a large role in the radar's ability to detect targets and the subsequent calculation of passage rate. These differences should be recognized when making direct site-to-site comparisons in passage rates.

Regardless of potential differences between radar survey locations, of the publicly available results from 36 other radar surveys, only one survey in fall 2005 in Wyoming County, New York, had a lower mean passage rate than that observed at Buckeye Wind Project (Table 2-1). There is currently no accurate quantitative method of directly correlating pre-construction passage rates at wind farms to operational impacts to birds and bats, although conventional wisdom would suggest that risk of collision would increase as passage rates of nocturnal migrants increases.

Some research suggests that bird migration may be affected by landscape features, such as coastlines, large river valleys, and mountain ranges. This has been documented for diurnally migrating birds such as raptors, but is not as well established for nocturnally migrating birds (Sielman *et al*. 1981; Bingman 1980; Bingman *et al*. 1982; Bruderer and Jenni 1990; Richardson 1998; Fortin *et al*. 1999; Williams *et al.* 2001; Diehl *et al*. 2003). However, surveys suggesting night-migrating birds are influenced by topography have typically been conducted in areas of steep topography, such as the most rugged areas of the northern Appalachians and the Alps. , There were no noticeable topographic influences on migration within the Project area.

The emerging body of surveys characterizing nocturnal bird movements shows a relatively consistent pattern in flight altitude, with most birds appearing to fly at altitudes of several hundred meters or more above the ground (Table 2-1). Comparison of flight altitude between survey sites as measured by radar is generally less influenced by site characteristics as the main portion of the radar beam is directed skyward, and the potential effects of surrounding vegetation on the radar's view can be more easily controlled. The flight altitude at Buckeye was very consistent with the altitudes observed at all other sites, regardless of landscape (Table 2-1).

Table 2-1. Summary of available fall avian radar survey results

Project Site	Number of Survey Nights	Number of Survey Hours	Landscape	Average Passage Rate (t/km/hr)	Range in Nightly Passage Rates	Avg. Flight Direction	Avg. Flight Altitude (m)	% Targets Below Turbine Altitude	Citation
Fall 1998									
Harrisburg, NY	35	n/a	Great Lakes plain/ADK foothills	122	n/a	181	182	45	Cooper and Mabee 2000
Wethersfield, Wyoming Cty, NY	35	n/a	Agricultural plateau	168	n/a	179	154	57	Cooper and Mabee 2000
Fall 2003									
Westfield Chautauqua Cty, NY	30	180	Great Lakes shore	238	10-905	199	532	(125 m) 4 %	Cooper *et al.* 2004c
Mt. Storm, Grant Cty, WV	45	270	Forested ridge	241	8-852	184	410	n/a	Cooper *et al.* 2004b
Fall 2004									
Franklin, Pendleton Cty, WV	34	349	Forested ridge	229	18-643	175	583	(125 m) 8%	Woodlot 2005a
Prattsburgh, Steuben Cty, NY	30	315	Agricultural plateau	193	12-474	188	516	(125 m) 3%	Woodlot 2005b
Prattsburgh, Steuben Cty, NY	45	292.5	Agricultural plateau	200	18-863	177	365	(125 m) 9.2%	Mabee *et al.* 2005a
Martindale, Lancaster, Cty, PA	n/a	n/a	Reclaimed minelands	187	n/a	188	436	(n/a) 8%	Young 2006
Casselman, Somerset Cty, PA	n/a	n/a	Reclaimed minelands	174	n/a	219	448	(n/a) 7%	Young 2006
Deerfield, Bennington Cty, VT (Existing Facility)	28	300	Forested ridge	175	7-519	194	438	(100 m) <1%	Woodlot 2005c
Deerfield, Bennington Cty, VT (Western Expansion)	14	159	Forested ridge	193	8-1121	223	624	(100 m) 5%	Woodlot 2005c
Deerfield, Bennington Cty, VT (Valley Site)	13	136	Forested ridge	150	58-404	214	503	(100 m) < 1%	Woodlot 2005c
Deerfield, Bennington Cty, VT (3 sites combined)	28	595	Forested ridge	178	7-1121	212	611	(100 m) 3%	Woodlot 2005c
Sheffield, Caledonia Cty, VT	18	176	Forested ridge	114	19-320	200	566	(125 m) 1%	Woodlot 2006a

Table 2-1. Summary of available fall avian radar survey results (cont.)

Project Site	Number of Survey Nights	Number of Survey Hours	Landscape	Average Passage Rate (t/km/hr)	Range in Nightly Passage Rates	Avg. Flight Direction	Avg. Flight Altitude (m)	% Targets Below Turbine Altitude	Citation
Fall 2005									
Churubusco, Clinton Cty, NY	38	414	Great Lakes plain/ADK foothills	152	9-429	193	438	(120 m) 5%	Woodlot 2005l
Ellenberg, Clinton Cty, NY	n/a	n/a	Great Lakes plain/ADK foothills	197	n/a	162	333	(n/a) 12%	Mabee *et al.* 2006a
Dairy Hills, Clinton Cty, NY	n/a	n/a	Agricultural plateau	94	n/a	180	466	(n/a) 10%	Young *et al.* 2006
Flat Rock, Lewis Cty, NY	n/a	n/a	Great Lakes plain/ADK foothills	158	n/a	184	415	(n/a) 8%	ED&R 2006a
Clayton, Jefferson Cty, NY	37	385	Agricultural plateau	418	83-877	168	475	(150 m) 10%	Woodlot 2005m
Bliss, Wyoming Cty, NY	8	n/a	Agricultural plateau	440	52-1392	n/a	411	(125 m) 13%	Young 2006
Perry, Wyoming Cty, NY	n/a	n/a	Agricultural plateau	64	n/a	180	466	(125 m) 10%	Young 2006
Sheldon, Wyoming Cty, NY	36	347	Agricultural plateau	197	43-529	213	422	(120 m) 3%	Woodlot 2005n
Howard, Steuben Cty, NY	39	405	Agricultural plateau	481	18-1434	185	491	(125 m) 5%	Woodlot 2005o
Fairfield, Herkimer Cty, NY	38	423	Agricultural plateau	691	116-1351	198	516	(125 m) 4%	Woodlot 2005p
Jordanville, Herkimer Cty, NY	38	404	Agricultural plateau	380	26-1019	208	440	(125 m) 6%	Woodlot 2005q
Munnsville, Madison Cty, NY	31	292	Agricultural plateau	732	15-1671	223	644	(118 m) 2%	Woodlot 2005r
Deerfield, Bennington Cty, VT	32	324	Forested ridge	559	3-1736	221	395	(100 m) 13%	Woodlot 2005s
Kibby, Franklin Cty, ME (Mountain)	12	115	Forested ridge	565	109-1107	167	370	(125 m) 16%	Woodlot 2006d
Kibby, Franklin Cty, ME (Range 1)	12	101	Forested ridge	201	12-783	196	352	(125 m) 12%	Woodlot 2006d
Kibby, Franklin Cty, ME (Valley Site)	5	13	Forested valley	452	52-995	193	391	(125 m) 16%	Woodlot 2006d
Mars Hill, Aroostook Cty, ME	18	117	Forested ridge	512	60-1092	228	424	(120 m) 8%	Woodlot 2005t

Table 2-1. Summary of available fall avian radar survey results (cont.)

Project Site	Number of Survey Nights	Number of Survey Hours	Landscape	Average Passage Rate (t/km/hr)	Range in Nightly Passage Rates	Avg. Flight Direction	Avg. Flight Altitude (m)	% Targets Below Turbine Altitude	Citation
Fall 2006									
Chateaugay, Franklin Cty, NY	35	327	Agricultural plateau	643	38-1373	212	431	(120 m) 8%	Woodlot 2006j
Wethersfield, Wyoming Cty, NY	56	n/a	Agricultural plateau	256	31-701	208	344	(125 m) 11%	Mabee *et al.* 2006c
Centerville, Allegany Cty, NY	57	n/a	Agricultural plateau	259	12-877	208	350	(125 m) 12%	Mabee *et al.* 2006c
Lempster, Sullivan Cty, NH	32	290	Forested ridge	620	133-1609	206	387	(125 m) 8%	Woodlot 2007a
Stetson, Penobscot Cty, ME	12	77	Forested ridge	476	131-1192	227	378	(125 m) 13%	Woodlot 2007b
Fall 2007									
Buckeye Wind Power Project, Champaign and Logan Cty, OH	30	n/a	Agricultural plateau	74	1-404	194	393	(125m) 5%	This Report

2.5 CONCLUSIONS

Radar surveys during the fall 2007 migration period suggest that bird migration patterns in the vicinity of the Buckeye Wind Project are generally similar to patterns observed at other sites in the region. Migration activity varied throughout the season, which is probably largely attributable to weather patterns. The mean passage rate in the Project area was the second lowest when compared with passage rates for 36 publicly available radar survey results. Flight altitude and flight direction data indicate that nocturnal migrants were flying at altitudes well above the proposed maximum turbine heights (seasonal mean was 393 m) and were unimpeded by topography. The percent of targets flying below the proposed turbine altitudes was near the low end of the ranges observed at other sites.

3.0 Acoustic Bat Survey

A total of eleven bat species are known to occur in the state of Ohio, based on their normal geographic ranges. These include *Mytois* species; Indiana bat (*Myotis sodalis*), little brown bat (*M. lucifugus*), northern long-eared bat (*M. septentrionalis*), eastern small-footed bat (*M. leibii*), as well as other Microchiroptera species; silver-haired bat (*Lasionycteris noctivagans*), eastern pipistrelle (*Pipistrellus subflavus*)[3], big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), hoary bat (*L. cinereus*), evening bat (*Nycticeius humeralis*), and Rafinesque's big-eared bat (*Corynorhinus rafinesquii*). Of these, the Indiana bat is listed as a federally endangered species, and the eastern small-footed bat and the Rafinesque's big-eared bat are listed as endangered by the OH DNR. Although the Project area is slightly north of Rafinesque's big-eared bat's normal distribution, there is some potential for its occurrence in the vicinity of the Project area.

3.1 INTRODUCTION

To document bat activity patterns in the proposed Project area, Stantec conducted acoustic monitoring surveys with Anabat detectors during the fall migration season. Acoustic bat detectors allow for long-term monitoring of activity patterns of bats in a variety of habitats, including the air space approaching the rotor-swept zone of modern wind turbines. The acoustic bat survey conducted at the Buckeye Project was designed to document bat activity patterns near the rotor zone of the proposed turbines, at an intermediate altitude, and near the ground. Acoustic surveys were also intended to document bat activity patterns in relation to weather factors including wind speed, temperature, and relative humidity.

[3] The scientific name of the eastern pipistrelle is in the process of being changed to *Perimyotis subflavus*. However, the species is referred to as *Pipistrellus subflavus* and abbreviated as "PISU" throughout this report.

3.2 METHODS

3.2.1 Field Surveys

Anabat II detectors (Titley Electronics Pty Ltd.) were used for the duration of the fall 2007 acoustic survey. Each Anabat detector was coupled with CF Storage ZCAIM (Titley Electronics Pty Ltd.), which programmed the on/off times and stored data on removable compact flash cards. Anabat detectors are frequency division detectors, dividing the frequency of ultrasonic calls made by bats by a factor of 16 so that they are audible to humans, which record the bat calls for subsequent analysis. Anabat detectors were selected based upon their widespread use for this type of survey, their ability to be deployed for long periods of time, and their ability to detect a broad frequency range, which allows detection of all species of bats that could occur in the Project area.

Six detectors were deployed in the Project area and were programmed to passively record from 7:00 pm to 7:00 am from August 28 through October 29. Three detectors were deployed at each of the two 60 m met towers on site and were positioned to record calls of bats flying within the met tower openings. One met tower was located in the northern portion of the Project area, approximately nine miles due north of the southern met tower (Figure 3-1). Detectors were placed at each met tower in the following locations: high detectors were deployed on met towers at a height approaching the rotor sweep zone; low detectors were positioned on met towers approximately 10 m (33 ft) below the high detectors; and tree detectors were placed in trees approximately 3 m (9 ft) above the ground at the edge of the met tower clearings. The habitat surrounding the met towers was open agriculture, with the northern tower adjacent to an active corn field and the southern tower within a pasture.

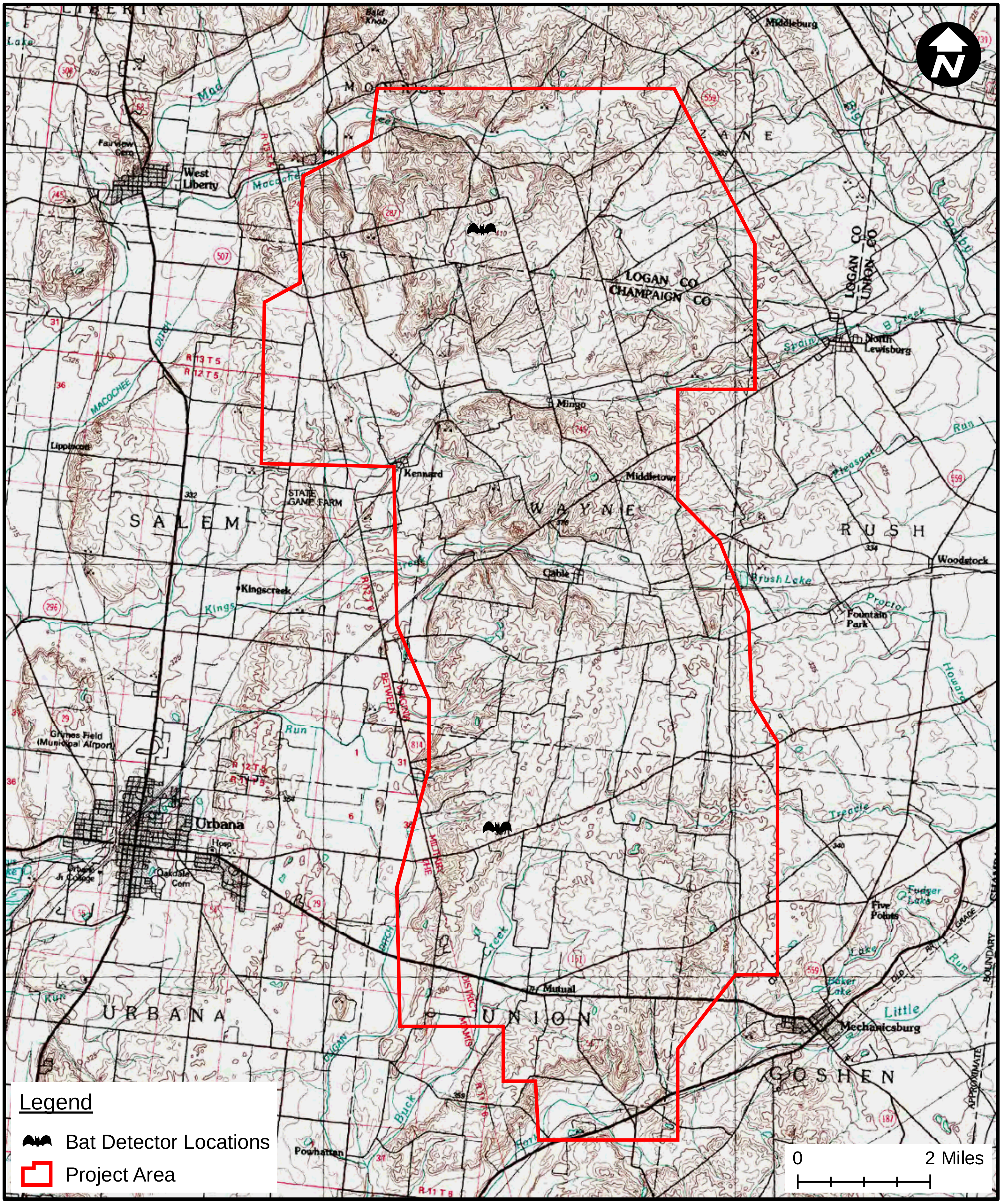
Each solar-powered Anabat system was deployed in a waterproof housing that enabled the detector to record while unattended for the duration of the survey. The housing suspended the Anabat microphone downward to give maximum protection from precipitation. To compensate for the downward position, a reflector shield of smooth plastic was placed at a 45-degree angle directly below the microphone. The angled reflector allowed the microphone to record the airspace horizontally surrounding the detector and was only slightly less sensitive than an unmodified Anabat unit.

Maintenance visits were conducted approximately every two weeks to check on the condition of the detectors and download data to a computer for analysis. The sensitivity of each Anabat system was set at between six and seven to maximize sensitivity while limiting ambient background noise and interference. The sensitivity of individual detectors was tested using an ultrasonic Bat Chirp (Reno, NV) to ensure that the detectors would be able to detect bats up to a distance of at least 10 m (33 ft).

3.2.2 Data Analysis

Potential call files were extracted from data files using CFCread© software. The default settings for CFCread© were used during this file extraction process, as these settings are recommended for the calls that are characteristic of northeastern bats. This software screens all data recorded by the bat detector and extracts call files using a filter. Using the default settings for this initial screen also ensures comparability between data sets. Settings used by the filter include a max TBC (time between calls) of 5 seconds, a minimum line length of 5 milliseconds, and a smoothing factor of 50. The smoothing factor refers to whether or not adjacent pixels can be connected with a smooth line. The higher the smoothing factor, the less restrictive the filter is, and the more noise files and poor quality call sequences are retained within the data set. A call is a single pulse of sound produced by a bat. A call sequence is a combination of two or more pulses recorded in a call file.

Following extraction of call files, each file was visually inspected to ensure that files created by static or some other form of interference that were still within the frequency range of Ohio bats were not included in the data set. Call sequences were identified based on visual comparison of call sequences to reference calls provided by Chris Corben, developer of the Anabat system. Bat calls typically include a series of pulses characteristic of normal flight or prey location (“search phase” calls) and capture periods (feeding “buzzes”) and visually look very different than static, which typically forms a diffuse band of dots at either a constant frequency or widely varying frequency, caused by wind, vibration, or other interference. Using these characteristics, bat call files are easily distinguished from non-bat files.



Prepared By:

Stantec

WOODLOT

107239-F31-BatLocation.mxd

Sheet Title:

Bat Detector Map

Project:

Buckeye Wind Power Project, Ohio

Date:	12/17/2007
Scale:	1" = 2 Miles
Proj. No.:	107239
Figure:	3-1

Bat call sequences were individually marked and categorized by species group, or "guild" based on visual comparison to reference calls. Qualitative visual comparison of recorded call sequences of sufficient length to reference libraries of bat calls allows for relatively accurate identification of bat species (O'Farrell *et al*. 1999, O'Farrell and Gannon 1999). A call sequence was considered of suitable quality and duration if the individual call pulses were "clean" (i.e., consisting of sharp, distinct lines) and at least five pulses were included within the sequence. Call sequences were classified to species whenever possible, using the reference calls described above. However, due to similarity of call signatures between several species, all classified calls have been categorized into four guilds for presentation in this report. This classification scheme follows that of Gannon *et al.* (2003) and is as follows:

- **Unknown (UNKN)** – all call sequences with too few pulses (less than five) or of poor quality (such as indistinct pulse characteristics or background static). These calls were further identified as either "high frequency unknown" (HFUN) for calls above 35 kHz or "low frequency unknown" (LFUN) for calls below 35 kHz; all potential evening bat call sequences would be grouped under the high frequency unknown category.

- **Myotid (MYSP)** – All bats of the genus *Myotis*. While there are some general characteristics believed to be distinctive for several of the species in this genus, these characteristics do not occur consistently enough for any one species to be relied upon at all times when using Anabat recordings;

- **Red bat/pipistrelle (RBEP)** – Eastern red bats and eastern pipistrelles. Like many of the other northeastern bats, these two species can produce calls distinctive only to each species. However, significant overlap in the call pulse shape, frequency range, and slope can also occur. Evening bats would also be included in this guild; and

- **Big brown/silver-haired/hoary bat (BBSHHB)** – This guild will be referred to as the big brown guild. These species' call signatures commonly overlap and have therefore been included as one guild in this report. Although the presence of Rafinesque's big-eared bat was not confirmed, their occurrence should also not be ruled out as there is some potential for this species to occur in the vicinity of the Project area, any big-eared call sequences would be included in this guild.

This guild grouping represents a conservative approach to bat call identification (Hayes 2000). Since some species do sometimes produce calls unique only to that species, all calls were identified to the lowest possible taxonomic level before being grouped into the listed guilds. Tables and figures in the body of this report will reflect those guilds. However, since species-specific identification did occur in some cases, each guild will also be briefly discussed with respect to potential species composition of recorded call sequences.

Once all of the call files were identified and categorized in appropriate guilds, nightly tallies of detected calls were compiled. Mean detection rates (number of calls/detector-night) for the entire sampling period were calculated for each detector and for all detectors combined. It is important to note that detection rates indicate only the number of calls detected and do not necessarily reflect the number of individual bats in an area. For example, a single individual can produce one or many call files recorded by the bat detector, but the bat detector cannot differentiate between individuals of the same species producing those calls. Consequently, detections recorded by the bat detector system likely over-represent the actual number of bats that produced the recorded calls.

3.2.3 Ceilometer and Radar Data

Nocturnal radar surveys and hourly ceilometer surveys were also conducted concurrently with the acoustic bat monitoring on 25 nights during the fall sampling period. While conclusive differentiation between bats and birds is not possible using radar, work conducted by Woodlot using radar and thermal imaging cameras indicates that nocturnal targets that move erratically or in curving paths are typically bats, while those with straight flight paths are birds. Additionally, while bats can create radar flight paths more similar to birds (i.e., straight flight path), no birds were observed creating the erratic radar flight paths observed to be created by some bats (Woodlot, unpublished observations).

Targets with erratic flight paths, similar to those previously observed to be created by bats were noted during the analysis of the radar video data. Nightly tallies of these targets were then made. Additionally, the ceilometer observations made during the radar survey were an opportunity to document birds and bats flying at low altitude over the radar site. Any bats observed during the ceilometer surveys were recorded.

3.2.4 Weather Data

Weather data was collected by EverPower at both the northern and southern met tower locations. Met towers collect wind speed and temperature at an elevation of 60 m above the proposed development area. A passive data logger was also deployed by Woodlot at the south met tower location. This data logger collected temperature, relative humidity, and dew point data from September 1 to October 29. Data was collected at 10-minute intervals by data loggers (HOBO Pro v2 U23-001, Onset Computer Corporation) placed on the tree bat detector system. The mean, maximum, and minimum temperature, relative humidity, and dew point were calculated for each night.

3.3 RESULTS

3.3.1 Detector Call Analysis

Detectors were deployed August 28 and continued to record data through October 29, for a total of 226 detector-nights (2,712 hours), although survey effort varied between detectors (Table 3-1). Each site recorded a large quantity of data, and some of the detectors recorded with little interruption. It is important to note that Anabat detectors occasionally power-down or experience other unexpected technical problems, and recordings are interrupted resulting in data loss. This is a typical issue with Anabat detectors. Four of the six detectors were not operational due to technological problems at various times during the survey (Appendix B, Table 6). However, this data loss is not considered to be of significant concern. It is expected that no major bat movements were missed, as there was always at least one detector functioning at both the north and south sample locations at all times during the survey (Appendix B; Table 6). All equipment issues were resolved before the end of the migration season resulting in adequate data collection at the deployment sites.

A total of 1,522 bat calls sequences were recorded at the six bat detectors across the Project area (Table 3-1). The south tree detector operated for 24 days and recorded 681 bat passes with an overall detection rate of 28.38 bat passes/detector night. The north low detector recorded 57 nights of operation and 275 bat passes with an overall detection rate of 4.82 bat passes/detector night. The south high detector operated for 57 nights and recorded 222 bat passes with an overall detection rate of 3.89 bat passes/detector night. The north high detector operated for 52 nights, recorded 176 bat call sequences and had an overall detection rate of 3.38 bat passes/detector night. The north tree detector operated for 25 nights and recorded 88 bat calls with an overall detection rate of 3.52 bat passes/detector night. The south low detector operated for 11 nights and recorded 80 bat passes with an overall detection rate of 7.27 bat passes/detector night.

Table 3-1. Summary of bat detector field survey effort and results, fall 2007.

Location	Dates	# Detector-Nights*	# Recorded Sequences	Detection Rate **	Maximum # Calls Recorded ***
North High	8/28 – 9/11 & 9/23 – 10/29	52	176	3.38	41
North Low	8/28 – 10/23	57	275	4.82	35
North Tree	8/28 – 9/21	25	88	3.52	13
South High	8/29 – 10/24	57	222	3.89	17
South Low	8/29 - 9/8	11	80	7.27	37
South Tree	9/24 & 10/2 - 10/24	24	681	28.38	311
Overall	8/28 -10/24	226	1522	6.73	--

* Detector-night is a sampling unit during which a single detector is deployed overnight. On nights when two detectors are deployed, the sampling effort equals two detector-nights, etc.

** Number of bat passes recorded per detector-night.

*** Maximum number of bat passes recorded from any **single** detector for a 12-hour sampling period.

Appendix B provides a series of tables with more specific information on the nightly timing, number, and species composition of recorded bat call sequences. Specifically, Appendix B Tables 1 through 6 provide information on the number of call sequences by guild and species (where possible) recorded at each detector and the weather conditions for that night. The numbers of calls per night detected by all detectors varied from night to night. During the fall migration season there appeared to be an increase in bat passes at the functioning detectors from October 2 to October 9. This increase in activity was observed at four of the six detectors (two detectors were malfunctioning during this time). Temperatures during the eight days ranged from a nightly mean of 13.5°C to 23.1°C (56 to 74ºF) then the nightly mean dropped as low as 4.8°C (41ºF) three days after the increased activity. Throughout the fall migration season, the number of call sequences peaked around the 8:00 pm hour and again at 11:00 pm followed by a decline in recorded call sequences for the remainder of the night (Figure 3-2).

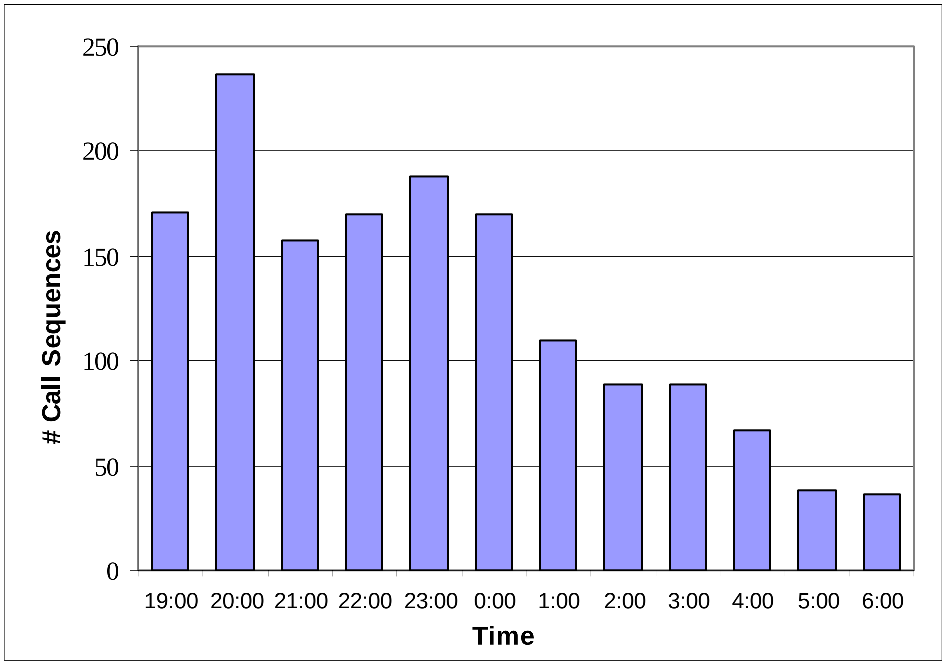


Figure 3-2. Timing of bat call sequences recorded by hour, fall 2007

The majority of the recorded call sequences (48%) recorded at all six detectors were labeled as unknown due to very short call sequences (less than five pulses) or poor call signature formation (probably due to a bat flying at the edge of the detection zone of the detector or flying away from the microphone) (Table 3-2). Of the calls that were identified to species or guild, those of the big brown guild were the most common (34% of all call sequences), followed by the species within the red bat/eastern pipistrelle guild (18% of all call sequences). Less than 1 percent of all call sequences were attributable to *Myotis* species.

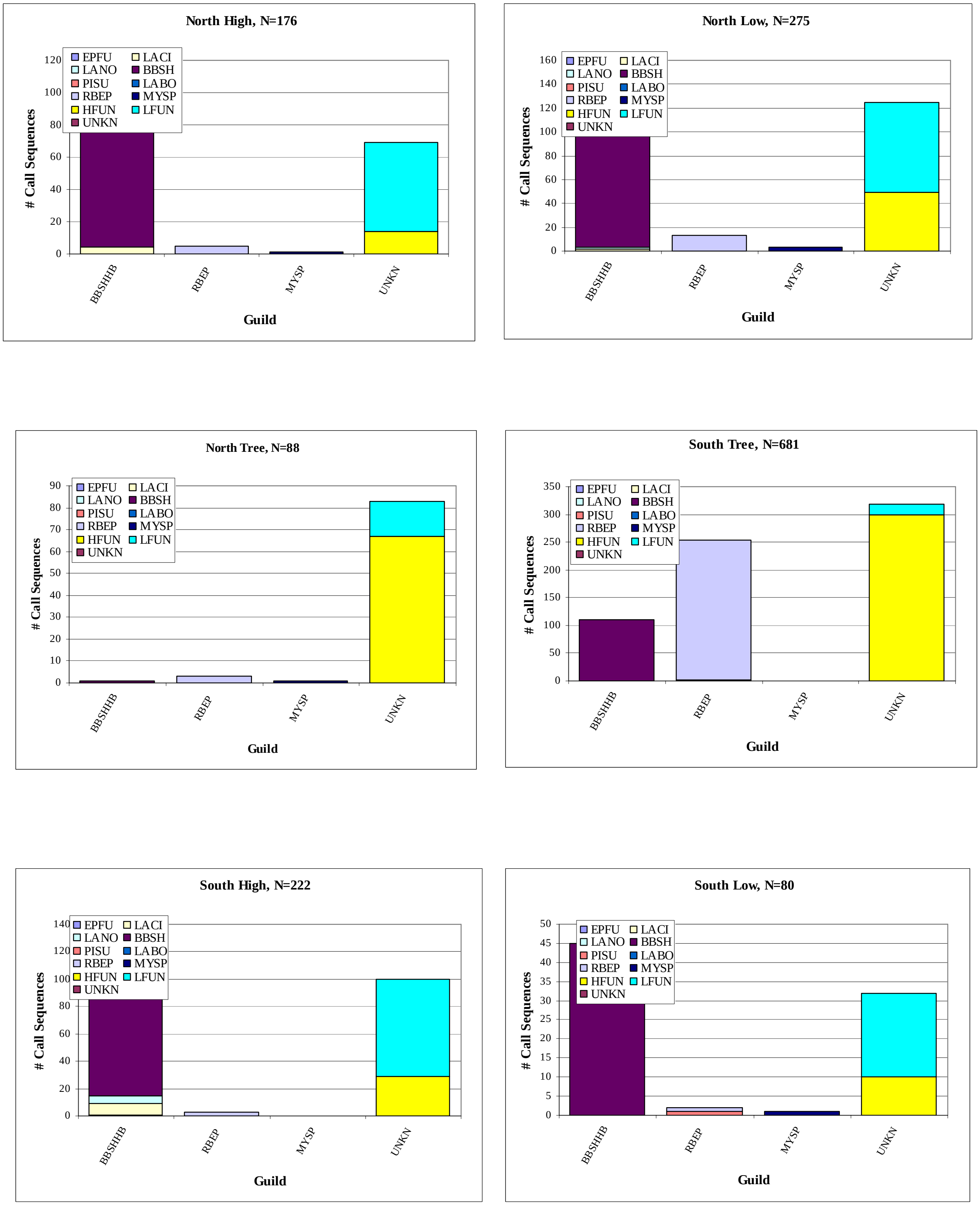
Table 3-2. Summary of the composition of recorded bat call sequences, fall 2007

Detector	Guild				Total
	Big brown guild	Red bat/ E. pipistrelle	Myotis	Unknown	
North High	101	5	1	69	176
North Low	134	13	3	125	275
North Tree	1	3	1	83	88
South High	119	3	0	100	222
South Low	45	2	1	32	80
South Tree	110	253	0	318	681
Total	***510***	***279***	***6***	***727***	***1,522***

Both the north high and the south high detectors recorded similar species compositions during the fall migration season. More than half of the call sequences recorded at the northern high detector were from species of the BBSHHB guild (57%) and low frequency unknown (31%) calls. Only one *Myotis* call sequence was recorded at the north high detector and no *Myotis* calls were recorded at the south high detector (Figure 3-3).

Although the south low detector only operated for 11 nights, the majority of observed species were a similar species composition as the north low detector. The north low and the south low detectors also saw similar patterns of guild presence. The BBSHHS guild comprised the majority of species call sequences recorded at the north detector (49%), followed by low frequency unknown species (28%) (Figure 3-3). The southern low detector saw a similar species composition despite the limited time of operation (56% BBSHHB and 28% low frequency unknown). The results for the high and low detectors at both the north and south ends of the Project area are consistent with results from other acoustic bat survey sites across the northeast.

FIGURE 3-3. Summary of suspected bat call sequence species composition, by detector.



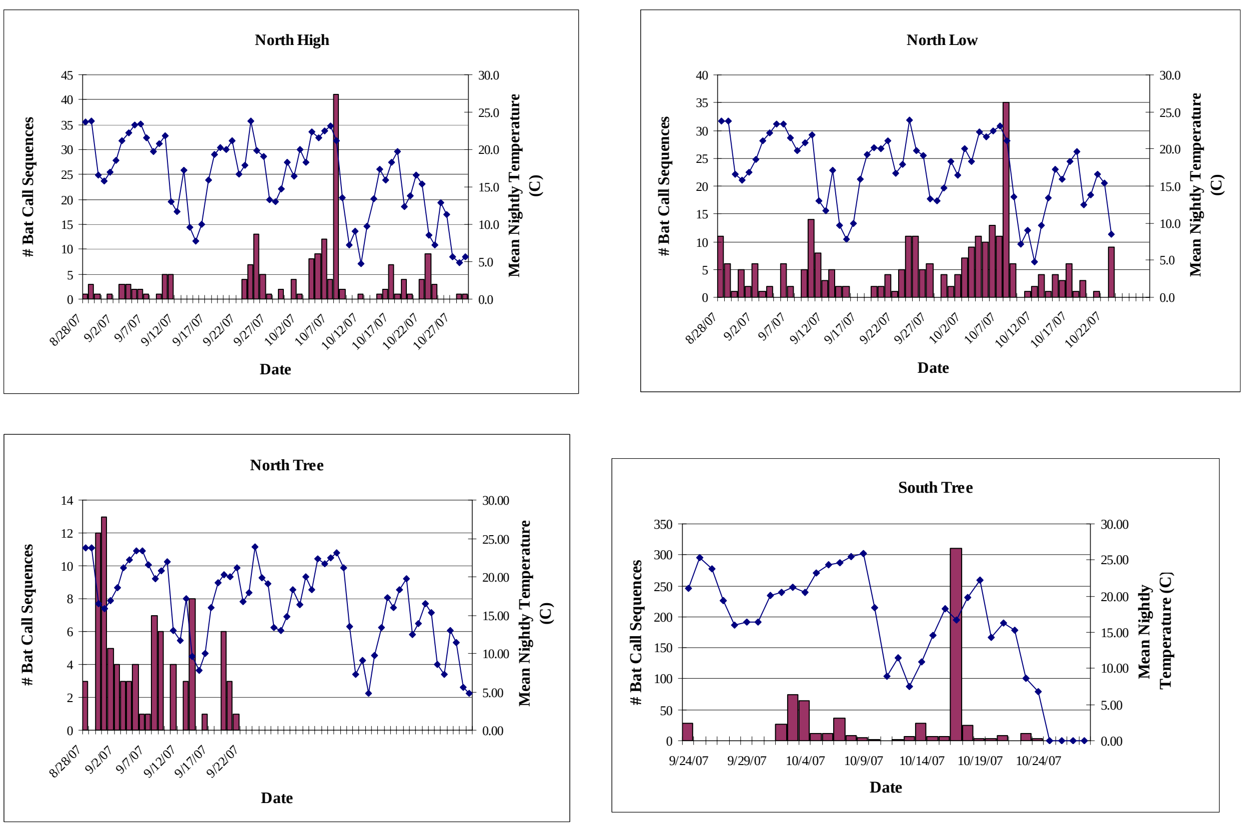
3.3.2 Ceilometer and Radar Surveys

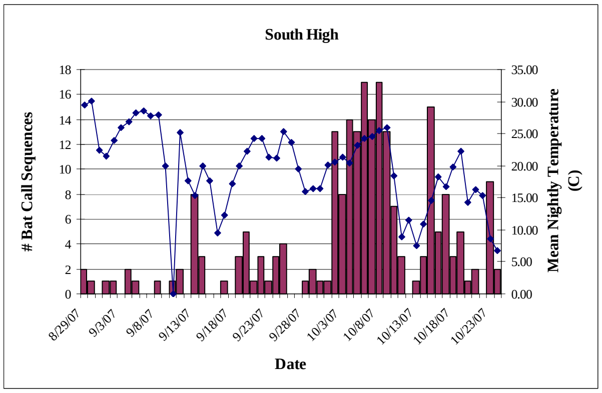
Eleven bats were observed during the course of 276 five-minute ceilometer observation periods conducted during the course of the radar surveys. During analysis of the radar survey video data, of the total 4,183 targets, 0.19 percent of target trails were identified as potential bats. These observations were generally distributed throughout the sampling period. Stantec could see no correlation between the total number of recorded bat call sequences and ceilometer, radar target, or radar passage rates.

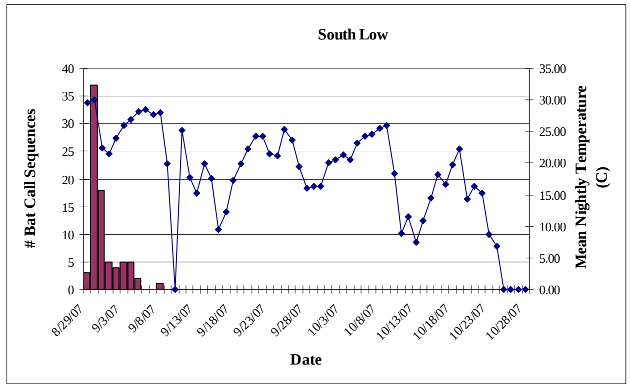
3.3.3 Weather Data

Mean nightly wind speeds in the Project area from August 28 through October 29, 2007, varied between 2.3 and 9.8 m/s at the northern met tower and 0.6 and 9.6 m/s at the southern met tower. Mean nightly temperatures varied between 4.8 ºC (40 ºF) and 23.9 ºC (75 ºF) at the northern met tower and 13.5 ºC (56 ºF) and 23.1 ºC (74 ºF) at the southern met tower (Figure 3-4).

Figure 3-4. Nightly mean temperature (blue line) and bat detections (red bars).







3.4 DISCUSSION

Bat echolocation surveys in fall migration season provide some insight into activity patterns, possible species composition, and timing of movements of bats in the Project area. Bat activity seemed to peak at all of the detector sights by early to mid October and decreased for the remaining of the survey season. The overall mean detection rate during the fall survey period was 6.73 calls/detector night. This rate is similar to other fall bat detector surveys conducted recently (Table 3-4). The north tree and the south low detectors were not operating during a period of increased bat activity from October 2 to October 9 which could have affected the overall detection rate.

Table 3-4. Summary of available fall bat detector survey results

Project Site	Landscape	Calls/Detector Night	Citation
Fall 2004			
Prattsburgh, Steuben County, NY	Agricultural plateau	2.22	Woodlot 2005b
Cohocton, Steuben County, NY	Agricultural plateau	2.00	Woodlot 2005b
Sheffield, Caledonia County, VT	Forested ridge	1.76	Woodlot 2006a
Franklin, Pendleton County, WV	Forested ridge	9.24	Woodlot 2005a
Fall 2005			
Churubusco, Clinton County, NY	Great Lakes plain/ADK foothills	5.56	Woodlot 2005l
Clayton, Jefferson County, NY	Agricultural plateau	4.70	Woodlot 2005m
Sheldon, Wyoming County, NY	Agricultural plateau	34.92	Woodlot 2005n
Howard, Steuben County, NY	Agricultural plateau	31.06	Woodlot 2006o
Cohocton, Steuben County, NY	Agricultural plateau	1.57	Woodlot 2006c
Fairfield, Herkimer County, NY	Agricultural plateau	1.70	Woodlot 2005p
Jordanville, Herkimer County, NY	Agricultural plateau	4.79	Woodlot 2005q
Munnsville, Madison County, NY	Agricultural plateau	2.32	Woodlot 2005r
Sheffield, Caledonia County, VT	Forested ridge	1.18	Woodlot 2006a
Deerfield, Bennington County, VT	Forested ridge	0.52	Woodlot 2005s
Redington, Franklin County, ME	Forested ridge	4.20	Woodlot 2005u
Mars Hill, Aroostook County, ME	Forested ridge	0.83	Woodlot 2005t
Fall 2006			
Chateaugay, Clinton County, NY	Agricultural plateau	5.10	Woodlot 2006j
Brandon, Franklin County, NY	Agricultural plateau	13.10	Woodlot 2006j
Wethersfield, Wyoming Co., NY	Agricultural plateau	0.30	Woodlot 2006l
Centerville, Allegany County, NY	Agricultural plateau	0.06	Woodlot 2006l
Sheffield, Caledonia County, VT	Forested ridge	1.10	Woodlot 2006a
Lempster, Sullivan County, NH	Forested ridge	3.47	Woodlot 2007a
Kibby, Franklin County, ME	Forested ridge	0.20	Woodlot 2006m
Stetson, Penobscot County, ME	Forested ridge	2.60	Woodlot 2007b

Bat calls were identified to guild within this report, although calls were provisionally categorized by species when possible during analysis. Certain species, such as the eastern red bat and hoary bat have easily identifiable calls, whereas other species, such as the big brown bat and silver-haired bat are difficult to distinguish acoustically. Similarly, certain Myotids, such as the little brown bat, are far more common and have slightly more distinguishable calls than other species. The following paragraphs discuss each guild separately and address likely species composition of recorded bats within each guild.

The MYSP guild includes all four species of *Myotis* potentially occurring in the Project area, including the little brown bat, northern long-eared bat, eastern small-footed bat, and the federally endangered Indiana bat. Of these species, the little brown bat and northern long-eared bat are by far the most common and have calls that tend to be slightly more distinguishable using the Anabat system. All six detectors operating during the fall migration season only captured six *Myotis* species calls. These calls lacked specific detailed to be identified to a specific *Myotis* species.

The RBEP guild includes the eastern pipistrelle and eastern red bat. Eastern red bats have relatively unique calls which span a wide range of frequency and have a characteristic hooked shape and variable minimum frequency. Eastern pipistrelles tend to have relatively uniform calls, with a constant minimum frequency and a sharply curved profile. Of the 279 calls classified as RBEP, only two calls could be identified as eastern pipistrelle. The remaining calls lacked specific detail to be classified as either a red bat or a pipistrelle and were placed in the RBEP guild. Eastern pipistrelles tend to be solitary foragers, often feeding over water and emerging around sunset, whereas eastern red bats will occasionally forage in groups of 20-30 individuals and emerge one to two hours after sunset (DeGraaf and Yamasaki 2001). High numbers of RBEP call sequences were recorded at the southern low detector. In one night 157 RBEP were recorded. This may have been a group of feeding bats passing the detector several times as they foraged in the met tower clearing. The BBSHHB guild includes the big brown bat, silver-haired bat, and hoary bat.

Within this grouping, the hoary bat has easily distinguishable calls characterized by highly variable minimum frequencies often extending below 20 kHz, and a hooked profile similar to the eastern red bat. Calls of silver-haired bats and big brown bats are occasionally distinguishable, but often overlap in range and can be difficult to distinguish, especially when comparing short duration calls typical of those recorded during passive monitoring. Of the 510 calls classified as BBSHHB, 14 were hoary bats and seven were silver-haired bats. The majority of the BBSHHB calls could only be identified to guild because of the poor call quality. Calls in this guild were more frequently detected at the high and low detectors than the two tree detectors.

Of the 1,522 total calls recorded at the Project area, 727, or 48% were classified as UNKN, due to their short duration or poor quality. However, these calls were identified as “high frequency” or “low frequency”. For the purposes of this analysis, “high frequency” call fragments were defined as having a minimum frequency above 30 kHz, and “low frequency” calls were defined as having a minimum frequency below 30 kHz. For the northern and southern high and low detectors, low frequency unknown calls were more common than high frequency unknown calls.

The opposite was true for both the northern and southern tree detectors where unknown high frequency calls were more common than unknown low frequency calls.

Differences in detection rates between guilds at the various detectors deployed in the Project area may reflect varying vertical distribution and habitat preferences of bat species (Hayes 2000). Recent research (Arnett 2006) found that small *Myotis* species were more frequently recorded at lower altitudes while larger, low frequency species were typically recorded more often at higher altitudes. In forested habitat, both large and small species were recorded in greater numbers at a medium altitude of 22 m, rather than at 1.5 m or 44 m. Although 48% of all calls recorded during the fall season were unknown, the low frequency and high frequency calls seen in the Project area fit a similar pattern. The higher passage rates observed at lower detectors should be interpreted with caution; those numbers could be a result of multiple passes from a single bat during nightly feeding activities. Consequently the number of call sequences may not reflect the actual number of individual bats.

Bat activity patterns during migration seem to be related to weather conditions based on mortality surveys and acoustic surveys. Acoustic surveys have documented a decrease in bat activity rates as wind speed increase and temperatures decrease, and bat activity has been shown to correlate negatively to low nightly mean temperatures (Hayes 1997, Reynolds 2006). Similarly, weather factors appeared related to bat collision mortality rates documented at two facilities in the southeastern United States, with mortality rates negatively correlated with both wind speed and relative humidity, and positively correlated to barometric pressure (Arnett 2005). These patterns suggest that bats are more likely to migrate on nights with low wind speeds (less than 4-6 m/s) and generally favorable weather (warm temperatures, low humidity, high barometric pressure). At all of the six detectors the highest nightly peak of bat activity was usually followed by a sharp drop in mean nightly temperature. This association provides anecdotal evidence of a relationship between temperature and bat activity levels recorded by Anabat detectors.

Statistical relationships were established between nightly call sequence totals and weather variables as determined from onsite met towers and HOBO data loggers. A small negative correlation was observed between wind speed and nightly call sequences at both low detectors (-0.2). A small positive correlation was observed between relative humidity and nightly call sequences at the South High detectors (0.2). A slightly large correlation was documented between temperature and nightly call sequences at the North Low detector (0.36). It is expected that a more complete data set with a full years worth of data would exhibit stronger correlations between relative levels of bat activity and weather variables. From what was documented during the fall 2007 survey period there is some quantitative and some qualitative evidence that bat activity increases with an increase in mean nightly temperature, decreases with an increase in mean nightly wind speed, and increases with rises in relative humidity. These observations are deduced from the small correlations exhibited by four of the detectors.

Although several surveys have documented heavy bat activity in the first few hours after sunset (Anthony *et al*. 1981), temporal variation in activity levels is considerable (Hayes 1997). Hourly distribution of activity may be a result of weather variables and not strongly linked to hour after sunset.

Results of acoustic surveys must be interpreted with caution. Considerable room for error exists in identification of bats based upon acoustic calls alone, especially if a site or regionally specific library of recorded reference calls is not available. Also, detection rates are not necessarily correlated with the actual numbers of bats in an area, because it is not possible to differentiate between individual bats (Hayes 2000). Stantec can provide a digital file of all acoustic calls, including all information about species identification and timing of calls from each detector on an hourly and nightly basis, should that information be desired.

3.5 CONCLUSIONS

The acoustic bat survey conducted at the Project area provided a valuable dataset which established general trends in species composition, fall bat migration characteristics and bat behavior in relation to weather patterns. The results of this survey should be interpreted with caution, as there is room for error in the identification of bat species based on the characteristics of their echolocation call sequences alone. The grouping of call sequences into guild categories represents a conservative approach to this type of analysis and likely provides the most realistic depiction of the species detected in the Project area. The data serve to provide a baseline of bat activity patterns and probable species composition in the Project area. It is expected that the results of this survey will help provide an accurate portrayal of the general characteristics of the local bat community, when viewed in conjunction with the results of the future bat echolocation surveys.

4.0 Diurnal Raptor Survey

4.1 INTRODUCTION

The Project area is located in the Central Continental Hawk Flyway. Geography and topography are major factors in shaping migration dynamics in this flyway. The orientation of the Great Lakes and inland mountain ranges influence diurnal migrants in central Canada and the mid-West to fly generally southwestward to their wintering grounds in fall and northeastward in the spring, with considerable east to west movement along the Great Lake shorelines (Kerlinger 1989, Kellogg 2004). The juxtaposition of the Appalachian mountain ranges and large bodies of water influence the distribution of raptor migration. Away from features such as the Lake Erie shore, the Alleghany and Appalachian plateaus may provide "leading lines" for hawks to follow (Kellogg 2004). Away from plateau “leading lines” and shores, raptors may utilize low relief upland areas; however, migration is not expected to concentrate in landscapes suboptimal for migration, such as the interior of the mid-west. There are twenty species of raptors typically observed in this flyway.

In order to minimize energy expenditure, raptors typically use ridgelines or shorelines to gain altitude via thermal development or ridge-generated updrafts (Kerlinger 1989). Areas of northern Ohio, on and near Lake Erie, support concentrations of migrant raptors which typically avoid lengthy water crossings. The topography surrounding the Buckeye Wind Project does not contain any outstanding features that typically concentrate raptors by providing reliable updrafts, such as high relief ridges and plateaus. Raptor migration through central Ohio is likely less concentrated than in other areas of the Central flyway because ridges and lake shores are not prevalent.

The Project is located in the south-central portion of the state in the Bellefontaine Uplands physiographic region, a sub-region of the Central Ohio Till Plains. This region is characterized by low to moderate relief (250 ft) hills formed by glacial processes during the last glacial maximum. Well to the east of the Project area, the Alleghany Plateaus rise to slightly higher elevations with much greater relief. It is suspected that the majority of raptor migration, away from the Lake Erie shoreline, would occur along the escarpments and leading lines of the Alleghany Plateau area.

It is probable that raptors migrating through central Ohio exhibit broad front migratory behavior, in which the migrants move across the landscape with little or no deviation due to topographic features. Therefore, it was suspected that raptor migration at the proposed Project would not be in great magnitudes or high diversity.

There is potential conflict between wind power and raptors because raptor migration is generally in and along higher elevations (Mueller and Berger 1967), such as ridge tops and areas that have a steep or substantial difference in topographic relief. These areas can provide updrafts to facilitate raptor movements and can also be productive locations for wind power generation. Raptor mortality at wind farms in the U.S. has been low at wind farms with modern turbine models, ranging from 0 to 0.07 raptors/turbine/year (Erickson *et al* 2002).

Woodlot conducted a fall raptor survey to determine if significant raptor migration occurred in the vicinity of the proposed Project. The survey was conducted on 11 days during the months of August, September and October. The goal of the survey was to document the occurrence of raptors in the vicinity of the Project area, including the number and species, approximate flight altitude, general direction and flight path, as well as other notable flight behavior.

4.2 RAPTOR METHODS

4.2.1 Field Surveys

Raptor surveys were conducted from a hill top south west of Mingo, Ohio at an elevation of approximately 402 m (1,320 ft) (Figure 4-1). The observation point offered good views to the north, west, and east. The observation site was in open and active pastureland, in a region central to the Project area. The observation site provided optimal visibility and was near a 100 m communication tower which provided an excellent reference by which to judge individual raptor flight altitudes.

Raptor surveys occurred on 11 days from August 30 to October 11, 2007, and were generally conducted from 9:00 am to 3:00 pm in order to include the time of day when the strongest thermal updrafts are typically produced and when the majority of raptor migration activity generally occurs. Days with favorable flight conditions, produced by high-pressure systems bringing northerly winds, and days following the passage of a weather front were targeted.

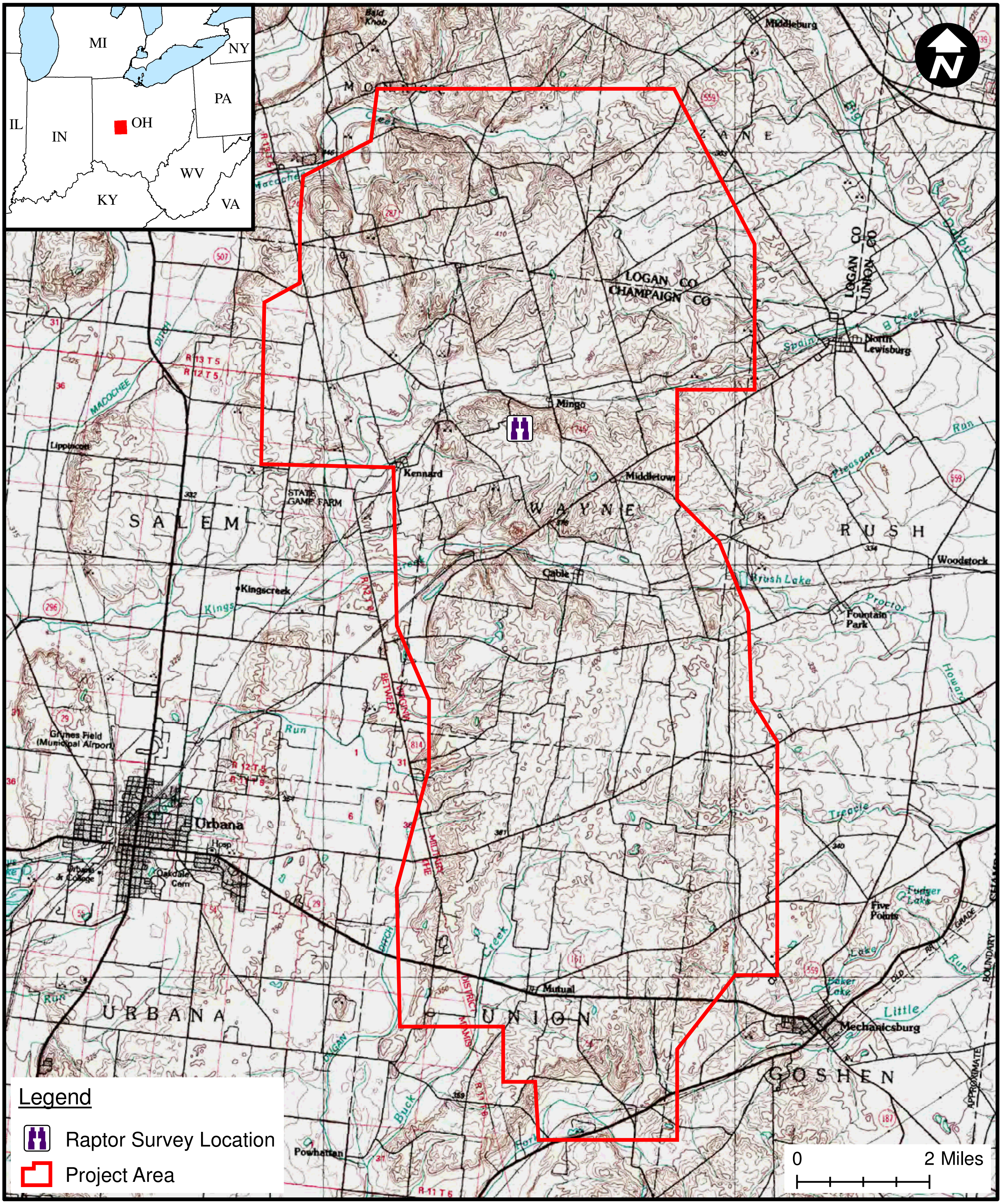
Surveys were based on methods developed by the Hawk Migration Association of North America (HMANA 2007). Observers scanned the sky and surrounding landscape for raptors flying through the area. Observations were recorded onto HMANA data sheets, which summarize the data by hour. Detailed notes on each observation, including location and flight path, flight altitude, and activity of the bird, were recorded. Flight altitudes were categorized as less than or greater than 125 m (412 ft) and 150 m (492 ft) above ground, the proposed maximum heights of the proposed wind turbines with blades oriented straight up. Nearby objects with known altitudes, such as the large communication tower and surrounding trees, were used to gauge flight altitudes. Information regarding the raptors' behavior, and whether a raptor was observed in the same locations throughout the survey period, was used to differentiate between migrant and resident birds. When possible, general flight paths and flight altitudes of individuals observed were plotted on topographic maps of the Project area.

Hourly weather observations, including wind speed, wind direction, temperature, percent cloud cover, and precipitation, were recorded on HMANA data sheets. Birds that flew too rapidly or were too far to accurately identify were recorded as unidentified to genus.

4.2.2 Data Analysis

Field observations were summarized by species for each survey day and for the whole survey period. This included a tally of the total number of individuals observed for each species, the observation rate (birds/hour), and an estimate of how many observations were suspected residents. The total number of birds, by species and by hour, was also calculated, as was the species composition of birds observed flying below and above 125 m (412 ft) and 150 m (492 ft). Finally, the mapped flight locations of individuals were reviewed to identify any overall patterns for migrating raptors.

Raptor observations from the Project area were compared to fall 2007 hawk watch count data (Appendix C, Table 4) from 14 sites (Figure 4-2); data are made available on the HMANA web site or from HMANA yearly reports. Comparisons were also made to 17 fall diurnal raptor surveys conducted from 1996 to 2006 that were publicly available for other wind projects through the northeast (Appendix C, Table 5).



Prepared By:

Stantec

WOODLOT

107239-F41-RaptorObsv.mxd

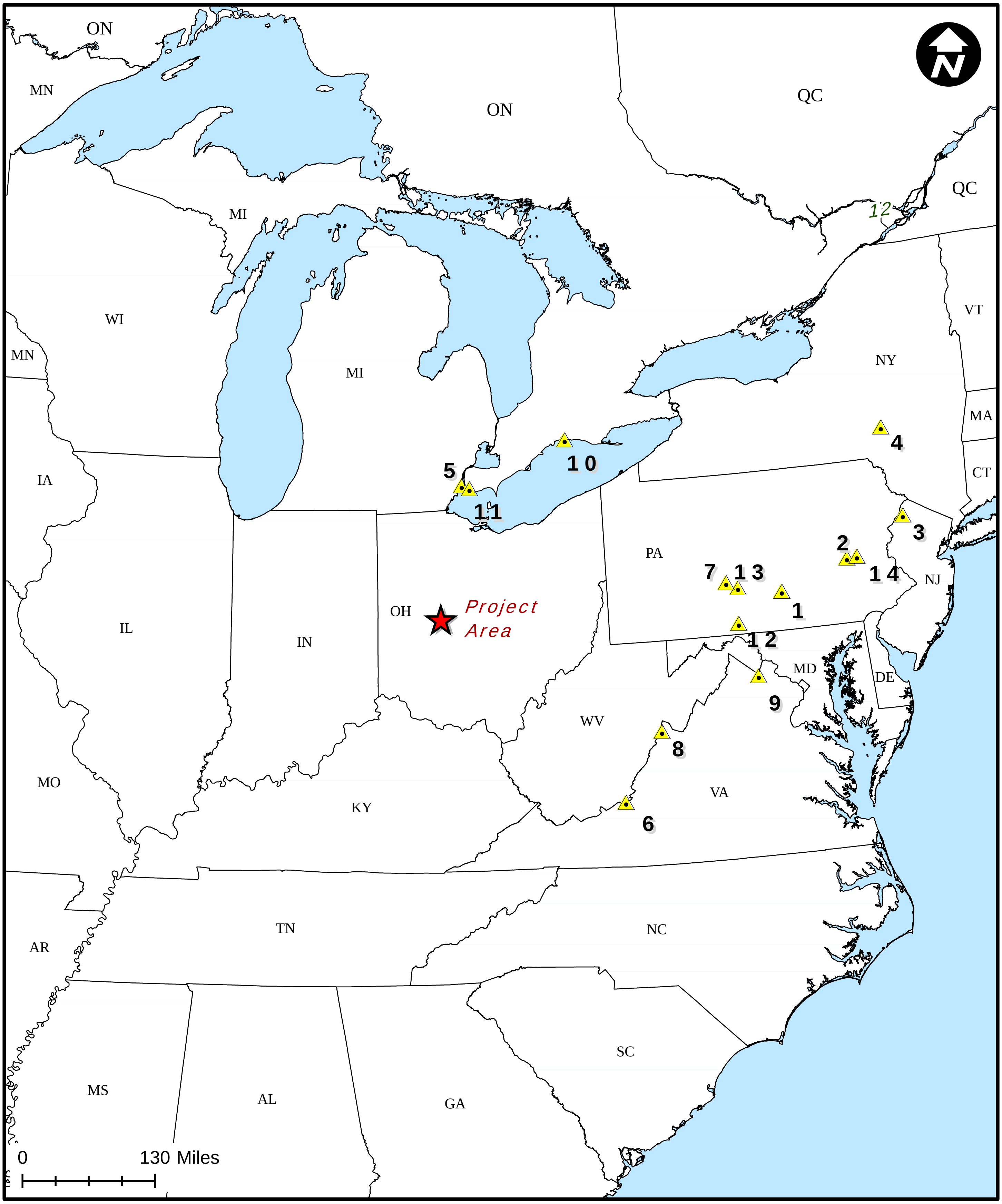
Sheet Title:

Raptor Survey Location Map

Project:

Buckeye Wind Power Project, Ohio

Date:	12/10/2007
Scale:	1" = 2 Miles
Proj. No.:	107239
Figure:	4-1



Prepared By:

Stantec

WOODLOT

107239-F42-HawkWatch.mxd

Sheet Title:

Hawk Watch Observation Sites

Project:

Buckeye Wind Power Project

Date: January 2008

Scale: 1" = 130 Miles

Proj. No.: 107239

Figure: 4-2

4.3 RAPTOR RESULTS

Surveys were conducted on mostly clear to partly cloudy days with no precipitation, allowing for optimal visibility. The survey location had exceptional views, and birds were seen in all areas to the outer edges of the observer's capability. During the survey in August temperatures averaged 22 ºC (72 ºF) with moderate winds from the north and northeast. Temperatures ranged from 13 ºC to 33 ºC (55 to 91 ºF) during the five survey days in September, and from 11 ºC to 31ºC (52 to 88 ºF) during October, with an overall mean temperature of 23 ºC (73 ºF) during the entire 11 day survey period.

The development of thermals on survey days was evident as temperatures increased and cumulus clouds developed. Although days with predominantly north winds were targeted, winds were variable throughout the survey period. The majority of survey days had winds from the north or northwest, with a few days averaging more southwesterly winds, wind speed were generally moderate throughout the survey period (0 – 25 km/hr).

Surveys were conducted for a total of 66 hours during the 11 survey days. A total of 421 raptors, representing eight species, were observed during that time, yielding an overall observation rate of 6.4 birds/hour (Figure 4-3). Throughout the 11 survey days, the range of passage rates varied from 2.5 to 11.8 birds/hour. Daily count totals ranged from 15 to 67 raptors. The high count of 67 raptors occurred on September 28 when winds were moderate (1 – 11 km/hr) and predominantly northwest. Temperatures during this survey ranged from 20 ºC to 27 ºC (68 to 81 ºF).

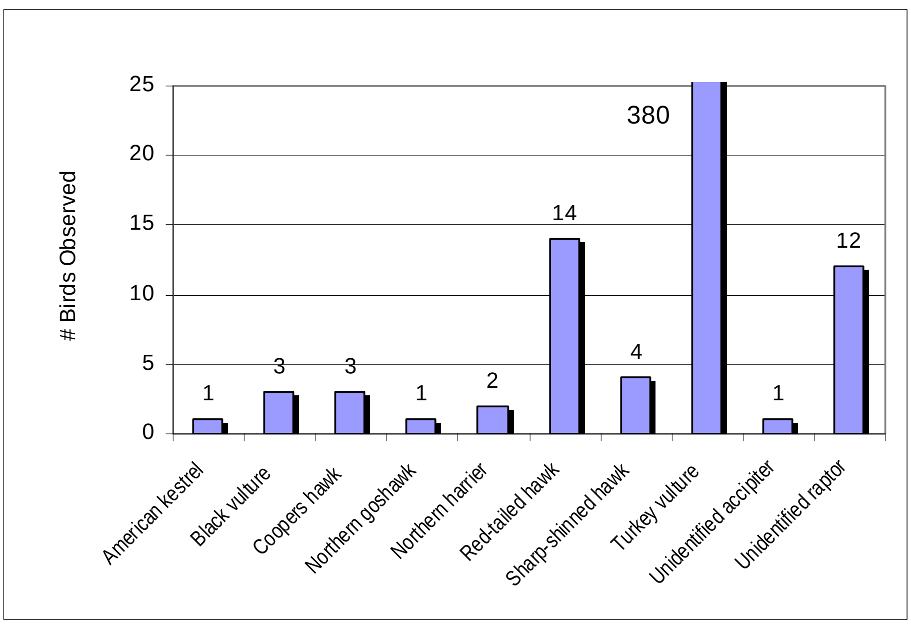


Figure 4-3. Species composition of raptors observed during raptor surveys fall 2007

Turkey vulture (*Cathartes aura)* [4] was by far the most abundant species observed in the area during the fall survey period (N=380, 90%). Red-tailed hawk (*Buteo jamaicensis*) was the second most commonly observed species accounting for 3 percent of the total observations (N=14). A number of unidentified raptors were seen; these were too far from the observer to accurately determine genus. Other species observed in low numbers included three species of accipiter [Cooper's hawk (*Accipiter cooperii*), sharp-shinned hawk (*Accipiter striatus*), and northern goshawk (*Accipiter gentilis*)]. A single American kestrel (*Falco sparverius*) and two northern harriers (*Circus cyaneus*) were seen hunting along some of the open pasturelands. Three black vultures (*Coragyps atratus*) were observed flying over the Project area. Of the species observed during the fall survey period, the northern harrier is state-listed as endangered, and the sharp-shinned hawk and black vulture are state species of concern (Ohio Department of Natural Resources 2007).

Three percent of all reported observations were of birds believed to be resident to the Project area. Most residents were repeatedly observed foraging and perching at consistently similar locations throughout the survey period. In these cases, a particular individual may have been observed flying back and forth across a section of hillside or perching in an area repeatedly during the same day or on more than one survey day. However, for the most part (97%), raptors that were observed were believed to be actively migrating southward. The high numbers of turkey vulture seen during the survey are believed to have been a combination of migrants and residents using the area prior to or during the onset of migration which typically occurs in October (Kirk and Mossman 1998). It is assumed that some specific food resource concentration may have been near the observation point and attracted increased turkey vulture activity.

In addition to varying daily counts, the timing of raptor observations varied within each survey day. On average, raptor counts throughout the season peaked between 10:00 and 11:00 (Figure 4-4). Observations of raptors declined as the day progressed (Appendix A, Table 2). This pattern was consistent for most of the species observed in the Project area.

Flight altitudes were categorized as below 125 m (412 ft) and below 150 m (492 ft), two approximate proposed altitudes for the turbines. Overall, 78 percent of the raptors observed were flying less than 125 m agl, and 84 percent were observed below 150 m agl. Differences in flight altitudes between species were observed (Figures 4-5 and 4-6). The mean flight altitude (n= 380) of turkey vultures was less than 28 m; with 78 percent flying below 125 m and 84 percent flying below 150 m. The mean flight altitude (n = 14) of red-tailed hawks was 166 m, with 50 percent flying below 125 m, and 58 percent flying below 150 m. The flight habits of raptors in the Project area were variable, though migrants were often in similar locations within the observable airspace.

[4] While turkey vultures are not true raptors, they are diurnal migrants that exhibit flight characteristics similar to hawks and other raptors and are typically included during hawk watch surveys.

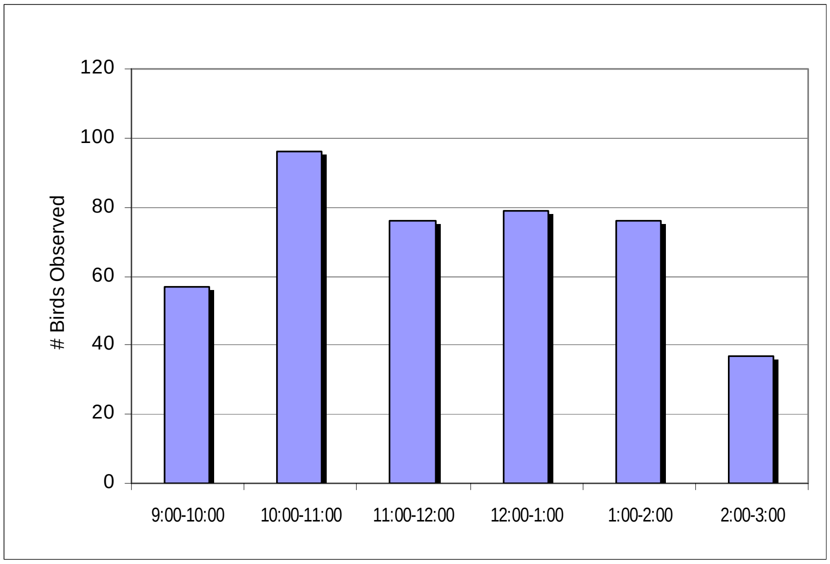


Figure 4-4. Hourly observation rates of raptors, fall 2007

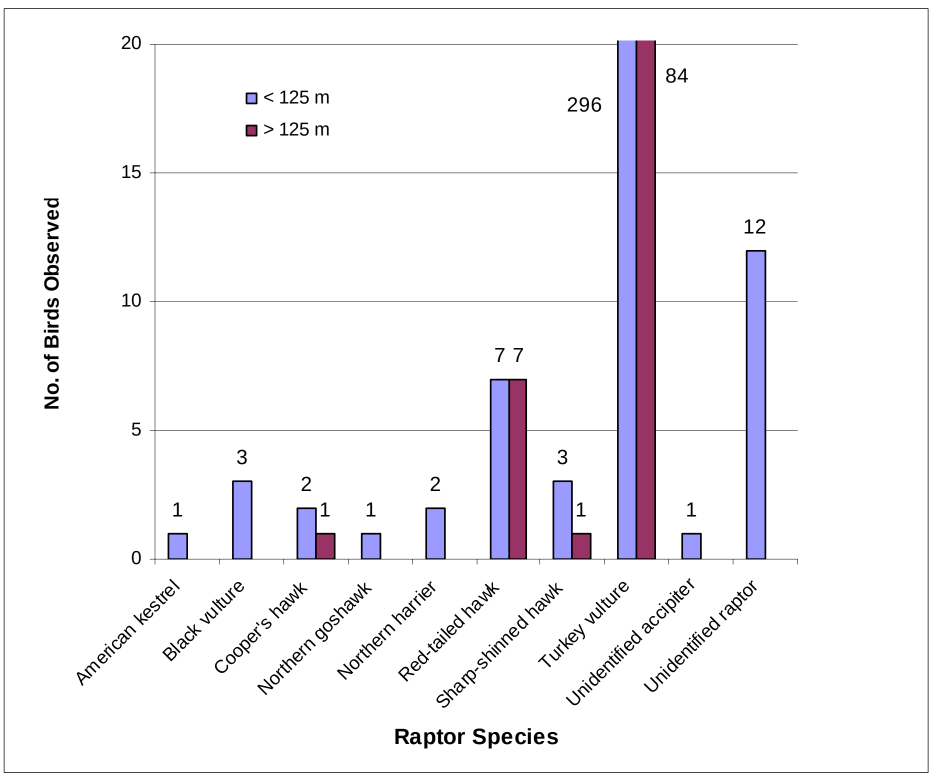


Figure 4-5. Summary of flight altitudes and number of individuals observed below 125 m during fall 2007 raptor migration surveys

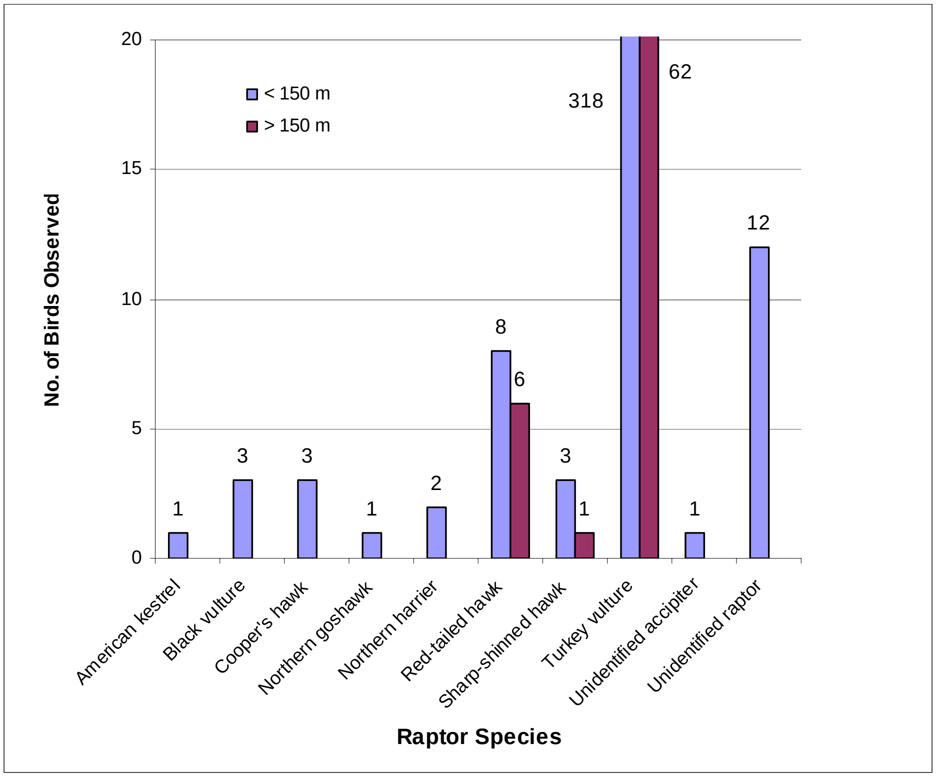


Figure 4-6. Summary of flight altitudes and number of individuals observed below 150 m during fall 2007 raptor migration surveys

4.4 RAPTOR DISCUSSION

A total of 421 individuals from eight different species of raptors were observed during 11 days and 66 hours of observation. Turkey vulture, which accounted for 90 percent of all raptor observations, was by far the most commonly observed species on site. Turkey vulture is considered one of the most common raptor species in the eastern United States (Wheeler 2003). No federally threatened or endangered species were observed during the diurnal raptor surveys. Two northern harriers (one adult, one juvenile), a state-listed endangered species, were observed on October 10, hunting the fields near the observation site. A total of four sharp-shinned hawks were also observed. Also, three black vultures were detected flying over the Project area. The sharp-shinned hawks and black vultures are state species of concern.

The overall number of raptors observed in the Project area was low relative to the numbers observed at regional hawk watch sites. Observation rates at regional hawk watch sites ranged from 6.4 to 261.4 birds/hour during fall 2007 (Appendix C, Table 4). The most active site was at SMRR Lake Erie, Metro Park, Michigan, which is also the closest hawk watch site to the Project area (Site No. 5, Figure 4-2). At SMRR, a total of 156,295 raptors were counted during 598 survey hours (261.4 birds/hour). This was likely due to the close proximity of the site to Lake Erie, which is historically known to concentrate large numbers of raptors. The passage rate of 6.4 birds/hour for the Buckeye raptor survey was among the lowest reported in the Central Continental Flyway (Appendix C, Table 4) during fall 2007. It is important to note that survey effort at most hawk watch sites is much greater than that of the surveys conducted at the proposed Buckeye Wind Project. The inclusion of hawk watch counts is considered a tool for comparison when other suitably comparable data are not available.

In addition to differing levels of effort, there are several potential reasons for the observed differences in passage rates between those observed in the Project area and at hawk watch sites in fall 2007. Geographic location can affect the magnitude of raptor migration occurring at a particular site. Sites that are located at prominent topographical points, such as Waggoner's Gap and Hawk Mountain, Pennsylvania, are situated along long ridgelines which tend to concentrate migrant use. Sites along Lake Erie and Lake Ontario also see a greater magnitude of migrants due to migration routes following shorelines. Organized hawk count locations typically target areas of known concentrated raptor migration activity. The lower passage rate at the Buckeye Project area is likely due to a lack of prominent landscape features that concentrate raptor migration.

When compared to 17 other publicly available raptor surveys conducted for wind projects with more comparable levels of effort than the hawk watch sites, the passage rate observed for the Buckeye Project (6.4 raptors/hour) was slightly above the average observed rate (mean = 4.4 ± 0.71). Passage rates for the 17 other surveys ranged from a low of 3.0 raptors/hour in Clinton County, New York in fall 2005, to a high of 12.72 raptors /hour in Bennington County, Vermont in fall 2004 (Appendix C, Table 5). Flight altitudes of raptors in the Project area indicate that percent of the raptors observed flying below 125 m, the height of most modern wind turbines, was similar to results of other fall raptor surveys for wind projects.

Differences between the average flight altitudes of different species were observed and could be due to differing flight altitude preferences, species behavior, or to limitations in species visibility. In general resident birds flew at lower altitudes than migrants because they typically undertake localized movements while foraging. Many residents were observed flying exclusively below the blade-swept area of proposed turbines (i.e. less than 40 m). Different species of raptors have a greater or lesser risk of collision with wind turbines, depending on various behavioral, stochastic, or environmental factors. For example, some species of raptors (e.g., northern goshawk and red-tailed hawk) migrate during time periods when thermal production is generally low and must rely on topographical features, such as side slopes and narrow ridge-tops that produce updrafts (Brandes 2005).

It is largely unknown what avoidance behavior raptors might exhibit when migrating near wind turbines. Unpublished observations of hawk migration activity at an existing facility in New England (Woodlot, unpublished data) indicate that the passage of small raptors (such as sharp-shinned hawks) often occurs below the blade-swept area of turbines, and the passage of larger raptors occurs well above the turbines. Birds have also been observed rising above operating turbines and then decreasing altitude between turbines. It is unclear if this type of presumed avoidance behavior would be characteristic of raptors in general or could be expected at other wind turbine facilities in North America.

4.5 RAPTOR CONCLUSIONS

The results of the field surveys indicate that fall raptor migration at the proposed Project is roughly average or low when compared to other sites in the region. It is likely that the geographical location of the Project area and its regional topography create conditions that are not optimal for raptor migration, causing relatively small concentrations of migrants flying through the Project area. Some raptors, specifically turkey vultures, use the Project area's low relief hills to gain altitude via updrafts and thermals during migration, and likely hunt the open agricultural lands during seasonal movements. The frequent observation of turkey vultures relative to the other raptor species observed was notable but not unexpected. Turkey vultures have been known to historically occur in central Ohio in relatively high densities (Coles 1944). Regional hawk watch counts often indicate a high incidence of turkey vultures (Appendix C, Table 4).

In general, migrants observed passing near or through the Project area flew higher than resident birds. Migrating birds were consistently observed gaining altitude near hillsides before following straight flight paths south and southeast. Thus, it is presumed that they were taking advantage of thermals and updrafts flowing up these hillsides. Based on the flight paths of migrants observed, it is likely that the low relief hills, where most wind turbines are being proposed, receive low use by migrating raptors. However, actual collision risk to migrating raptors at modern wind facilities remains largely unknown. Raptor migration, and indeed all avian migration behavior, is a complex phenomenon dependent on a number of variables that can differ from year to year. By undertaking diurnal raptor surveys, however, a greater understanding of the site specific migration occurring in the Project area may be gained, and a baseline of raptor migration activity can be documented.

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Appendix A

Radar survey results

Appendix A Table 1. Survey dates, results, level of effort, and weather at Buckeye Wind Project- Fall 2007

Date	Passage rate	Flight Direction	Flight Altitude (m)	% below 125m	Hours of Survey	Temperature (c)	Wind Speed (m/s)	Wind Direction (from)
9/5/2007	16	310	506	3%	11	23.3	7.3	147
9/6/2007	95	84	455	1%	11	23.4	5.9	194
9/9/2007	131	183	485	2%	11	20.8	4.6	167
9/10/2007	404	291	466	5%	11	21.9	4.0	55
9/11/2007	39	98	490	3%	11	13.0	5.0	209
9/12/2007	34	238	395	8%	10	11.7	6.3	356
9/13/2007	83	21	445	3%	10	17.2	6.3	128
9/14/2007	12	231	444	2%	11	9.7	5.9	264
9/15/2007	27	200	387	5%	11	7.8	4.1	1
9/16/2007	14	321	284	31%	11	10.0	5.9	120
9/17/2007	22	300	268	38%	10	15.9	7.4	135
9/18/2007	30	310	421	1%	11	19.3	6.9	156
9/21/2007	114	62	415	5%	10	21.2	7.0	176
9/22/2007	135	202	376	3%	11	16.7	7.0	270
9/23/2007	97	275	382	11%	11	17.9	7.6	96
9/24/2007	135	208	409	5%	11	23.9	6.0	158
9/25/2007	117	166	396	3%	11	19.8	5.4	238
9/27/2007	42	147	399	1%	11	13.3	5.0	281
10/1/2007	62	133	346	4%	11	16.4	5.1	217
10/2/2007	88	42	382	4%	11	20.0	8.0	231
10/3/2007	47	313	424	1%	11	18.3	3.1	199
10/4/2007	59	290	408	5%	11	22.3	5.6	170
10/5/2007	204	70	389	5%	11	21.6	5.5	188
10/6/2007	72	98	396	2%	11	22.5	3.6	207
10/7/2007	123	80	441	1%	7	23.1	2.3	250
10/9/2007	14	144	378	3%	10	13.5	5.8	278
10/10/2007	0	--	252	15%	11	7.2	5.0	299
10/11/2007	2	20	372	3%	11	9.1	4.5	302
10/12/2007	9	95	292	4%	9	4.8	2.9	334
10/13/2007	4	90	296	8%	10	9.7	3.6	306
Averages	**74**	**194**	**393**	**4%**	**318**			

Appendix A Table 2. Passage rates by hour, night, and for entire season-Buckeye Wind Project- Fall 2007

Night of	Passage Rate (targets/km/hr) by hour after sunset												Entire Night		
	1	2	3	4	5	6	7	8	9	10	11	12	Mean	Stdev	SE
9/5/2007	0	21	64	4	21	0	0	21	14	9	21	--	**16**	18	6
9/6/2007	163	171	257	193	129	43	14	7	39	21	5	--	**95**	90	27
9/9/2007	77	200	274	253	250	121	36	193	43	86	0	43	**131**	98	29
9/10/2007	621	479	525	614	675	593	268	225	355	327	86	75	**404**	211	64
9/11/2007	11	11	21	0	79	171	54	43	21	21	0	--	**39**	50	15
9/12/2007	21	21	46	43	54	34	40	43	21	54	--	0	**34**	17	5
9/13/2007	--	100	137	120	89	107	100	64	43	46	21	--	**83**	37	12
9/14/2007	21	32	21	30	21	11	0	0	11	0	0	0	**12**	12	4
9/15/2007	86	50	51	34	11	29	14	7	0	11	0		**27**	27	8
9/16/2007	54	11	7	34	14	0	10	21	5	0	7	0	**14**	16	5
9/17/2007	16	56	50	36	21	11	17	11	7	--	14	0	**22**	18	6
9/18/2007	43	99	32	57	21	0	21	29	18	21	0	21	**30**	27	8
9/21/2007	--	257	86	121	96	116	118	134	71	64	71	--	**114**	56	18
9/22/2007	193	171	225	211	79	139	182	129	134	114	38	0	**135**	69	21
9/23/2007	77	139	171	93	118	171	150	75	43	0	64	64	**97**	54	16
9/24/2007	188	200	171	150	75	139	120	86	157	129	193	11	**135**	56	17
9/25/2007	182	257	94	188	300	60	68	50	64	114	32	0	**117**	94	28
9/27/2007	50	86	64	71	71	46	48	43	14	4	0	7	**42**	29	9
10/1/2007	29	43	43	59	86	94	114	96	21	39	64	54	**62**	30	9
10/2/2007	289	150	64	114	75	71	64	64	21	59	32	50	**88**	72	22
10/3/2007	27	79	107	75	36	43	64	27	21	21	34	34	**47**	27	8
10/4/2007	21	64	75	16	61	100	86	43	69	64	71	43	**59**	25	7
10/5/2007	193	343	129	321	266	307	230	204	118	139	139	54	**204**	92	28
10/6/2007	86	86	54	107	43	129	75	86	59	43	43	50	**72**	28	8
10/7/2007	73	124	134	132	150	152	95	--	--	--	--	--	**123**	29	11
10/9/2007	50	43	13	34	0	0	--	5	7	0	0	0	**14**	19	6
10/10/2007	0	0	0	0	0	0	0	0	0	0	0	--	**0**	0	0
10/11/2007	11	0	0	0	0	11	0	0	0	4	0	0	**2**	4	1
10/12/2007	16	16	4	0	16	21	--	9	--	4	0	0	**9**	8	3
10/13/2007	0	11	--	0	5	5	16	0	0	0	0	4	**4**	5	2
Entire Season	**93**	**111**	**101**	**104**	**95**	**91**	**72**	**59**	**49**	**50**	**33**	**23**	**74**	**81**	**15**

Appendix A Table 3. Mean Nightly Flight Direction at Buckeye Wind Project - Fall 2007

Night of	Mean Flight Direction	Circular Standard Deviation
9/5/2007	310.397°	114.1°
9/6/2007	84.273°	81.796°
9/9/2007	182.629°	67.207°
9/10/2007	291.257°	86.237°
9/11/2007	98.056°	79.951°
9/12/2007	237.977°	72.835°
9/13/2007	21.461°	69.91°
9/14/2007	231.471°	74.965°
9/15/2007	200.248°	86.27°
9/16/2007	320.784°	109.408°
9/17/2007	299.784°	57.714°
9/18/2007	310.024°	58.705°
9/21/2007	61.874°	82.683°
9/22/2007	201.964°	56.166°
9/23/2007	274.886°	83.704°
9/24/2007	208.015°	152.866°
9/25/2007	166.478°	90.017°
9/27/2007	147.363°	65.029°
10/1/2007	133.157°	64.56°
10/2/2007	42.116°	95.886°
10/3/2007	313.464°	106.266°
10/4/2007	289.812°	105.202°
10/5/2007	69.693°	101.872°
10/6/2007	97.799°	113.082°
10/7/2007	79.557°	101.863°
10/9/2007	143.651°	56.563°
10/11/2007	20°	74.131°
10/12/2007	95.05°	77.796°
10/13/2007	90°	*****
Entire Season	**194**	**144**

Appendix A Table 4. Summary of mean flight altitudes by hour, night, and for entire season at Buckeye Wind Project - Fall 2007

Night of	Mean Flight Altitude (m) by hour after sunset												Entire Night			% of targets below 125 meters	% of targets below 150 meters
	1	2	3	4	5	6	7	8	9	10	11	12	Mean	STDV	SE		
9/5/07	329	460	454	506	592	609	609	553	437	573	448	--	506	89	27	3%	4%
9/6/07	419	439	483	425	420	--	459	514	459	448	481	--	455	31	10	1%	2%
9/9/07	495	539	526	502	437	557	489	459	450	466	421	--	485	43	13	2%	2%
9/10/07	374	453	501	499	499	527	--	438	430	365	316	720	466	107	32	5%	8%
9/11/07	388	562	607	542	539	523	491	481	433	405	414	--	490	72	22	3%	4%
9/12/07	388	532	408	407	452	385	368	443	461	466	408	20	395	126	36	8%	10%
9/13/07	357	495	520	442	544	463	447	400	401	434	389	--	445	58	17	3%	3%
9/14/07	506	549	431	459	453	434	442	431	395	363	418	--	444	50	15	2%	2%
9/15/07	289	417	445	374	438	410	382	416	364	416	302	--	387	52	16	5%	5%
9/16/07	92	149	254	405	530	204	479	368	182	--	174	--	284	151	48	31%	33%
9/17/07	158	373	302	218	217	179	239	--	468	325	350	117	268	105	32	38%	38%
9/18/07	407	477	394	331	512	406	477	409	443	415	363	--	421	53	16	1%	2%
9/21/07	460	545	420	451	434	419	401	350	375	364	353	405	415	55	16	5%	7%
9/22/07	435	474	476	425	386	401	379	315	321	321	329	255	376	69	20	3%	6%
9/23/07	448	399	--	413	386	365	370	333	504	533	132	319	382	106	32	11%	14%
9/24/07	379	492	507	541	454	393	416	395	338	308	321	365	409	75	22	5%	5%
9/25/07	309	--	459	371	374	421	411	412	365	380	420	431	396	41	12	3%	5%
9/27/07	401	479	471	492	458	393	432	418	378	351	301	216	399	80	23	1%	2%
10/1/07	297	375	367	292	349	391	401	359	359	314	300	--	346	39	12	4%	5%
10/2/07	340	376	396	396	404	362	365	392	394	417	331	414	382	28	8	4%	4%
10/3/07	200	402	418	426	472	490	519	481	448	386	446	404	424	81	23	1%	3%
10/4/07	318	457	441	455	456	376	420	399	496	341	361	380	408	54	16	5%	7%
10/5/07	401	390	391	399	411	382	448	384	382	410	356	318	389	32	9	5%	7%
10/6/07	310	427	406	399	329	405	402	482	361	410	456	367	396	49	14	2%	3%
10/7/07	345	452	447	505	457	443	438	--	--	--	--	--	441	48	18	1%	3%
10/9/07	359	410	362	427	431	338	458	414	414	391	322	209	378	67	19	3%	5%
10/10/07	95	307	272	312	486	163	134	549	275	230	95	111	252	148	43	15%	19%
10/11/07	--	360	372	356	387	366	413	341	374	370	371	381	372	18	6	3%	4%
10/12/07	265	293	315	304	302	268	295	321	272	317	260	--	292	22	7	4%	6%
10/13/07	158	291	283	406	323	384	375	187	308	276	299	268	296	73	21	8%	8%
Entire Season	335	427	418	416	431	395	412	409	389	386	343	317	393	35	10	4%	5%

-- Indicates no data for that hour.

Appendix A Table 5. Survey dates, results, level of effort, and weather at Buckeye Wind Project- Fall 2007

Night of	Radar Results			Ceilometer Results				Weather Conditions		
	Possible Bird Targets	Possible Bat Targets	Likely Insects	# of Obs Periods	Birds	Bats	Insects	Temp	Wind Speed (m/s)	Wind Direction (from)
9/5/2007	100%	0%	0%	n/a	n/a	n/a	n/a	23.3	7.3	147
9/6/2007	100%	0%	0%	11	1	4	511	23.4	5.9	194
9/9/2007	100%	0%	0%	11	1	3	396	20.8	4.6	167
9/10/2007	100%	0%	0%	11	0	1	557	21.9	4.0	55
9/11/2007	98%	2%	0%	11	0	1	463	13.0	5.0	209
9/12/2007	97%	3%	14%	11	0	0	359	11.7	6.3	356
9/13/2007	100%	0%	0%	11	0	0	327	17.2	6.3	128
9/14/2007	100%	0%	0%	11	0	0	357	9.7	5.9	264
9/15/2007	98%	2%	0%	11	0	0	49	7.8	4.1	1
9/16/2007	100%	0%	0%	11	0	0	69	10.0	5.9	120
9/17/2007	100%	0%	0%	11	0	0	107	15.9	7.4	135
9/18/2007	100%	0%	0%	11	0	0	278	19.3	6.9	156
9/21/2007	111%	0%	0%	11	0	0	516	21.2	7.0	176
9/22/2007	100%	0%	0%	11	0	0	448	16.7	7.0	270
9/23/2007	100%	0%	0%	11	0	0	399	17.9	7.6	96
9/24/2007	100%	0%	0%	11	0	0	417	23.9	6.0	158
9/25/2007	99%	1%	0%	11	0	0	185	19.8	5.4	238
9/27/2007	100%	0%	0%	11	0	0	225	13.3	5.0	281
10/1/2007	99%	1%	0%	11	0	0	239	16.4	5.1	217
10/2/2007	100%	0%	0%	n/a	n/a	n/a	n/a	20.0	8.0	231
10/3/2007	100%	0%	0%	11	0	1	324	18.3	3.1	199
10/4/2007	100%	0%	0%	11	0	0	288	22.3	5.6	170
10/5/2007	99%	1%	0%	11	0	0	285	21.6	5.5	188
10/6/2007	100%	0%	0%	11	0	0	257	22.5	3.6	207
10/7/2007	100%	0%	0%	3	0	0	169	23.1	2.3	250
10/9/2007	100%	0%	0%	11	0	0	472	13.5	5.8	278
10/10/2007	n/a	n/a	n/a	10	0	0	75	7.2	5.0	299
10/11/2007	100%	0%	0%	11	0	0	114	9.1	4.5	302
10/12/2007	100%	0%	0%	n/a	n/a	n/a	n/a	4.8	2.9	334
10/13/2007	100%	0%	0%	n/a	n/a	n/a	n/a	9.7	3.6	306
Total	**100%**	**0%**	**0%**	**277**	**2**	**10**	**7886**	**17**	**5**	**204**

Appendix B

Bat survey results

Appendix B Table 1. Summary of acoustic bat data and weather during each survey night at the North High detector – Fall 2007

		BBSHHB				RBEP			MYSP	UNKN						
Night of	**Operated Okay?**	**big brown bat**	**hoary bat**	**silver-haired bat**	**silver-haired/big brown**	**eastern pipistrelle**	**eastern red bat**	**pipistrelle/red bat**	**MYSP**	**high-frequency**	**low-frequency**	**unknown**	**Total**	**Wind Speed (m/s)**	**Relative Humidity (%)**	**Temperature (celsius)**
8/28/07	Y										1		**1**	5.2	n/a	23.7
8/29/07	Y		2								1		**3**	4.6	n/a	23.8
8/30/07	Y				1								**1**	6.6	n/a	16.5
8/31/07	Y												**0**	7.4	n/a	15.9
9/1/07	Y										1		**1**	6.3	47.3	16.9
9/2/07	Y												**0**	2.4	45.9	18.5
9/3/07	Y		1		1						1		**3**	3.7	49.7	21.2
9/4/07	Y				1						2		**3**	3.2	34.0	22.2
9/5/07	Y		1								1		**2**	7.3	35.7	23.3
9/6/07	Y										2		**2**	5.9	45.4	23.4
9/7/07	Y								1				**1**	6.3	46.5	21.5
9/8/07	Y												**0**	4.7	52.5	19.8
9/9/07	Y										1		**1**	4.6	48.4	20.8
9/10/07	Y				3						2		**5**	4.0	54.0	21.9
9/11/07	Y				3			1			1		**5**	5.0	46.5	13.0
9/12/07	N												**n/a**	6.3	85.7	11.7
9/13/07	N												**n/a**	6.3	56.7	17.2
9/14/07	N												**n/a**	5.9	78.7	9.7
9/15/07	N												**n/a**	4.1	77.1	7.8
9/16/07	N												**n/a**	5.9	76.7	10.0
9/17/07	N												**n/a**	7.4	59.4	15.9
9/18/07	N												**n/a**	6.9	58.4	19.3
9/19/07	N												**n/a**	3.6	59.3	20.2
9/20/07	N												**n/a**	5.8	86.1	20.0
9/21/07	N												**n/a**	7.0	64.6	21.2
9/22/07	N												**n/a**	7.0	64.8	16.7
9/23/07	Y				3						1		**4**	7.6	57.8	17.9
9/24/07	Y				5						2		**7**	6.0	64.0	23.9
9/25/07	Y				10						3		**13**	5.4	92.8	19.8
9/26/07	Y				4						1		**5**	3.7	98.6	19.1
9/27/07	Y							1					**1**	5.0	89.6	13.3
9/28/07	Y												**0**	5.1	70.3	13.0
9/29/07	Y				1						1		**2**	7.4	69.5	14.7
9/30/07	Y												**0**	8.0	51.9	18.3
10/1/07	Y				3						1		**4**	5.1	74.0	16.4
10/2/07	Y				1								**1**	8.0	68.9	20.0
10/3/07	Y												**0**	3.1	80.9	18.3
10/4/07	Y				6						2		**8**	5.6	75.9	22.3
10/5/07	Y				6						3		**9**	5.5	80.9	21.6
10/6/07	Y				8					1	3		**12**	3.6	73.9	22.5
10/7/07	Y				2						2		**4**	2.3	70.3	23.1
10/8/07	Y				26						15		**41**	6.0	68.3	21.1
10/9/07	Y				2								**2**	5.8	65.6	13.5
10/10/07	Y												**0**	5.0	79.4	7.2
10/11/07	Y												**0**	4.5	85.1	9.1
10/12/07	Y										1		**1**	2.9	81.5	4.8
10/13/07	Y												**0**	3.6	69.0	9.7
10/14/07	Y												**0**	7.6	72.4	13.4
10/15/07	Y									1			**1**	6.8	64.6	17.3
10/16/07	Y				1						1		**2**	4.7	98.0	15.9
10/17/07	Y				5					1	1		**7**	7.5	88.1	18.3
10/18/07	Y				1								**1**	9.8	85.8	19.7
10/19/07	Y							1		3			**4**	7.7	80.6	12.4
10/20/07	Y							1					**1**	8.8	55.5	13.8
10/21/07	Y												**0**	8.5	49.3	16.5
10/22/07	Y									4			**4**	5.0	98.0	15.4
10/23/07	Y				3			1		1	4		**9**	3.3	97.9	8.5
10/24/07	Y				1					1	1		**3**	9.2	91.2	7.3
10/25/07	Y												**0**	6.9	50.6	12.9
10/26/07	Y												**0**	6.8	40.6	11.4
10/27/07	Y												**0**	5.0	47.1	5.6
10/28/07	Y									1			**1**	3.0	40.1	4.8
10/29/07	Y									1			**1**	5.3	n/a	5.6
By Species		**0**	**4**	**0**	**97**	**0**	**0**	**5**	**1**	**14**	**55**	**0**	**176**	**n/o indicates detector was not operating on that night**		
By Guild		**101**				**5**			**1**	**69**						
		BBSHHB				**RBEP**			**MYSP**	**UNKN**			**Total**			

Appendix B Table 2. Summary of acoustic bat data and weather during each survey night at the North Low detector – Fall 2007

		BBSHHB				RBEP			MYSP	UNKN						
Night of	**Operated Okay?**	**big brown bat**	**hoary bat**	**silver-haired bat**	**silver-haired/big brown**	**eastern pipistrelle**	**eastern red bat**	**pipistrelle/red bat**	**MYSP**	**high-frequency**	**low-frequency**	**unknown**	**Total**	**Wind Speed (m/s)**	**Relative Humidity (%)**	**Temperature (celsius)**
8/28/07	Y				2			1		4	4		**11**	5.2	n/a	23.7
8/29/07	Y				1				1	2	2		**6**	4.6	n/a	23.8
8/30/07	Y									1			**1**	6.6	n/a	16.5
8/31/07	Y								2	3			**5**	7.4	n/a	15.9
9/1/07	Y				1					1			**2**	6.3	47.3	16.9
9/2/07	Y		1		1			1		2	1		**6**	2.4	45.9	18.5
9/3/07	Y										1		**1**	3.7	49.7	21.2
9/4/07	Y			1	1								**2**	3.2	34.0	22.2
9/5/07	Y												**0**	7.3	35.7	23.3
9/6/07	Y				2					2	2		**6**	5.9	45.4	23.4
9/7/07	Y									2			**2**	6.3	46.5	21.5
9/8/07	Y												**0**	4.7	52.5	19.8
9/9/07	Y				1			1		3			**5**	4.6	48.4	20.8
9/10/07	Y		1		5			1		3	4		**14**	4.0	54.0	21.9
9/11/07	Y				6						2		**8**	5.0	46.5	13.0
9/12/07	Y							1			2		**3**	6.3	85.7	11.7
9/13/07	Y				2					1	2		**5**	6.3	56.7	17.2
9/14/07	Y										2		**2**	5.9	78.7	9.7
9/15/07	Y									2			**2**	4.1	77.1	7.8
9/16/07	Y												**0**	5.9	76.7	10.0
9/17/07	Y												**0**	7.4	59.4	15.9
9/18/07	Y												**0**	6.9	58.4	19.3
9/19/07	Y										2		**2**	3.6	59.3	20.2
9/20/07	Y				2								**2**	5.8	86.1	20.0
9/21/07	Y				2			1			1		**4**	7.0	64.6	21.2
9/22/07	Y										1		**1**	7.0	64.8	16.7
9/23/07	Y				4						1		**5**	7.6	57.8	17.9
9/24/07	Y				5					3	3		**11**	6.0	64.0	23.9
9/25/07	Y				7			1		1	2		**11**	5.4	92.8	19.8
9/26/07	Y				1			1		2	1		**5**	3.7	98.6	19.1
9/27/07	Y				2					3	1		**6**	5.0	89.6	13.3
9/28/07	Y												**0**	5.1	70.3	13.0
9/29/07	Y				4								**4**	7.4	69.5	14.7
9/30/07	Y				1						1		**2**	8.0	51.9	18.3
10/1/07	Y				4								**4**	5.1	74.0	16.4
10/2/07	Y				5			1			1		**7**	8.0	68.9	20.0
10/3/07	Y				5						4		**9**	3.1	80.9	18.3
10/4/07	Y				9					1	1		**11**	5.6	75.9	22.3
10/5/07	Y				6						4		**10**	5.5	80.9	21.6
10/6/07	Y				9						4		**13**	3.6	73.9	22.5
10/7/07	Y				7						4		**11**	2.3	70.3	23.1
10/8/07	Y				22					1	12		**35**	6.0	68.3	21.1
10/9/07	Y				1					1	4		**6**	5.8	65.6	13.5
10/10/07	Y												**0**	5.0	79.4	7.2
10/11/07	Y				1								**1**	4.5	85.1	9.1
10/12/07	Y									2			**2**	2.9	81.5	4.8
10/13/07	Y				1					2	1		**4**	3.6	69.0	9.7
10/14/07	Y							1					**1**	7.6	72.4	13.4
10/15/07	Y				2					2			**4**	6.8	64.6	17.3
10/16/07	Y									2	1		**3**	4.7	98.0	15.9
10/17/07	Y				6								**6**	7.5	88.1	18.3
10/18/07	Y										1		**1**	9.8	85.8	19.7
10/19/07	Y				1					1	1		**3**	7.7	80.6	12.4
10/20/07	Y												**0**	8.8	55.5	13.8
10/21/07	Y							1					**1**	8.5	49.3	16.5
10/22/07	Y												**0**	5.0	98.0	15.4
10/23/07	Y				2			2		2	3		**9**	3.3	97.9	8.5
10/24/07	N												n/a	9.2	91.2	7.3
10/25/07	N												n/a	6.9	50.6	12.9
10/26/07	N												n/a	6.8	40.6	11.4
10/27/07	N												n/a	5.0	47.1	5.6
10/28/07	N												n/a	3.0	40.1	4.8
By Species		**0**	**2**	**1**	**131**	**0**	**0**	**13**	**3**	**49**	**76**	**0**	**275**	**n/o indicates detector not operating on that night**		
By Guild		**134**				**13**			**3**	**125**						
		BBSHHB				**RBEP**			**MYSP**	**UNKN**			**Total**			

Appendix B Table 3. Summary of acoustic bat data and weather during each survey night at the North Tree detector – Fall 2007

		BBSHHB				RBEP			MYSP	UNKN						
Night of	**Operated Okay?**	**big brown bat**	**hoary bat**	**silver-haired bat**	**silver-haired/big brown**	**eastern pipistrelle**	**eastern red bat**	**pipistrelle/red bat**	**MYSP**	**high-frequency**	**low-frequency**	**unknown**	**Total**	**Wind Speed (m/s)**	**Relative Humidity (%)**	**Temperature (celsius)**
8/28/07	Y									3			**3**	5.18	n/a	23.71
8/29/07	Y												**0**	4.6	n/a	23.8
8/30/07	Y							2		4	6		**12**	6.6	n/a	16.5
8/31/07	Y							1		12			**13**	7.4	n/a	15.9
9/1/07	Y								1	3	1		**5**	6.3	47.3	16.9
9/2/07	Y									4			**4**	2.4	45.9	18.5
9/3/07	Y									3			**3**	3.7	49.7	21.2
9/4/07	Y									2	1		**3**	3.2	34.0	22.2
9/5/07	Y									3	1		**4**	7.3	35.7	23.3
9/6/07	Y										1		**1**	5.9	45.4	23.4
9/7/07	Y									1			**1**	6.3	46.5	21.5
9/8/07	Y									7			**7**	4.7	52.5	19.8
9/9/07	Y									5	1		**6**	4.6	48.4	20.8
9/10/07	Y												**0**	4.0	54.0	21.9
9/11/07	Y				1					3			**4**	5.0	46.5	13.0
9/12/07	Y												**0**	6.3	85.7	11.7
9/13/07	Y									2	1		**3**	6.3	56.7	17.2
9/14/07	Y									7	1		**8**	5.9	78.7	9.7
9/15/07	Y												**0**	4.1	77.1	7.8
9/16/07	Y									1			**1**	5.9	76.7	10.0
9/17/07	Y												**0**	7.4	59.4	15.9
9/18/07	Y												**0**	6.9	58.4	19.3
9/19/07	Y									4	2		**6**	3.6	59.3	20.2
9/20/07	Y									2	1		**3**	5.8	86.1	20.0
9/21/07	Y									1			**1**	7.0	64.6	21.2
9/22/07	N												**n/a**	7.0	64.8	16.7
9/23/07	N												**n/a**	7.6	57.8	17.9
9/24/07	N												**n/a**	6.0	64.0	23.9
9/25/07	N												**n/a**	5.4	92.8	19.8
9/26/07	N												**n/a**	3.7	98.6	19.1
9/27/07	N												**n/a**	5.0	89.6	13.3
9/28/07	N												**n/a**	5.1	70.3	13.0
9/29/07	N												**n/a**	7.4	69.5	14.7
9/30/07	N												**n/a**	8.0	51.9	18.3
10/1/07	N												**n/a**	5.1	74.0	16.4
10/2/07	N												**n/a**	8.0	68.9	20.0
10/3/07	N												**n/a**	3.1	80.9	18.3
10/4/07	N												**n/a**	5.6	75.9	22.3
10/5/07	N												**n/a**	5.5	80.9	21.6
10/6/07	N												**n/a**	3.6	73.9	22.5
10/7/07	N												**n/a**	2.3	70.3	23.1
10/8/07	N												**n/a**	6.0	68.3	21.1
10/9/07	N												**n/a**	5.8	65.6	13.5
10/10/07	N												**n/a**	5.0	79.4	7.2
10/11/07	N												**n/a**	4.5	85.1	9.1
10/12/07	N												**n/a**	2.9	81.5	4.8
10/13/07	N												**n/a**	3.6	69.0	9.7
10/14/07	N												**n/a**	7.6	72.4	13.4
10/15/07	N												**n/a**	6.8	64.6	17.3
10/16/07	N												**n/a**	4.7	98.0	15.9
10/17/07	N												**n/a**	7.5	88.1	18.3
10/18/07	N												**n/a**	9.8	85.8	19.7
10/19/07	N												**n/a**	7.7	80.6	12.4
10/20/07	N												**n/a**	8.8	55.5	13.8
10/21/07	N												**n/a**	8.5	49.3	16.5
10/22/07	N												**n/a**	5.0	98.0	15.4
10/23/07	N												**n/a**	3.3	97.9	8.5
10/24/07	N												**n/a**	9.2	91.2	7.3
10/25/07	N												**n/a**	6.9	50.6	12.9
10/26/07	N												**n/a**	6.8	40.6	11.4
10/27/07	N												**n/a**	5.0	47.1	5.6
10/28/07	N												**n/a**	3.0	40.1	4.8
By Species		**0**	**0**	**0**	**1**	**0**	**0**	**3**	**1**	**67**	**16**	**0**	**88**	**n/o indicates detector not operating that night**		
By Guild		**1**				**3**			**1**	**83**						
		BBSHHB				**RBEP**			**MYSP**	**UNKN**			**Total**			

Appendix B Table 4. Summary of acoustic bat data and weather during each survey night at the South High detector – Fall 2007

		BBSHHB				RBEP			MYSP	UNKN						
Night of	Operated Okay?	big brown bat	hoary bat	silver-haired bat	silver-haired/big brown	eastern pipistrelle	eastern red bat	pipistrelle/red bat	MYSP	high-frequency	low-frequency	unknown	Total	Wind Speed (m/s)	Relative Humidity (%)	Temperature (celsius)
8/29/07	Y							1			1		**2**	1.6	n/a	29.54
8/30/07	Y										1		**1**	2.4	n/a	30.05
8/31/07	Y												**0**	5.5	n/a	22.44
9/1/07	Y				1								**1**	6.4	47.3	21.42
9/2/07	Y				1								**1**	5.4	45.9	23.98
9/3/07	Y												**0**	3.1	49.7	25.97
9/4/07	Y				1						1		**2**	4.2	34.0	26.87
9/5/07	Y				1								**1**	2.6	35.7	28.22
9/6/07	Y												**0**	5.4	45.4	28.51
9/7/07	Y												**0**	4.4	46.5	27.76
9/8/07	Y									1			**1**	6.6	52.5	27.99
9/9/07	Y												**0**	5.4	48.4	19.91
9/10/07	Y				1								**1**	n/a	54.0	n/a
9/11/07	Y				2								**2**	2.1	46.5	25.23
9/12/07	Y												**0**	6.9	85.7	17.66
9/13/07	Y				4						4		**8**	6.4	56.7	15.32
9/14/07	Y				3								**3**	5.2	78.7	19.96
9/15/07	Y												**0**	7.2	77.1	17.61
9/16/07	Y												**0**	3.7	76.7	9.54
9/17/07	Y										1		**1**	4.5	59.4	12.36
9/18/07	Y												**0**	6.5	58.4	17.22
9/19/07	Y				1						2		**3**	6.7	59.3	19.91
9/20/07	Y				2			1			2		**5**	2.7	86.1	22.21
9/21/07	Y				1								**1**	4.3	64.6	24.28
9/22/07	Y				2						1		**3**	4.5	64.8	24.33
9/23/07	Y				1								**1**	6.6	57.8	21.40
9/24/07	Y				1						2		**3**	6.4	64.0	21.15
9/25/07	Y				4								**4**	5.8	92.8	25.36
9/26/07	Y												**0**	6.7	98.6	23.72
9/27/07	Y												**0**	2.9	89.6	19.44
9/28/07	Y										1		**1**	2.8	70.3	15.98
9/29/07	Y				2								**2**	5.4	69.5	16.40
9/30/07	Y										1		**1**	6.4	51.9	16.41
10/1/07	Y				1								**1**	6.7	74.0	20.10
10/2/07	Y		2		7					2	2		**13**	7.4	68.9	20.52
10/3/07	Y				2						6		**8**	6.1	80.9	21.27
10/4/07	Y			4	3					2	5		**14**	1.4	75.9	20.46
10/5/07	Y				8						5		**13**	4.8	80.9	23.19
10/6/07	Y			1	10						6		**17**	5.0	73.9	24.31
10/7/07	Y			1	7						6		**14**	1.4	70.3	24.63
10/8/07	Y		3		8						6		**17**	0.6	68.3	25.46
10/9/07	Y				7					2	4		**13**	5.7	65.6	25.91
10/10/07	Y				1					1	5		**7**	7.0	79.4	18.36
10/11/07	Y				1					1	1		**3**	4.1	85.1	8.87
10/12/07	Y												**0**	5.9	81.5	11.44
10/13/07	Y				1								**1**	3.8	69.0	7.45
10/14/07	Y				1						2		**3**	5.1	72.4	10.86
10/15/07	Y		2		6					4	3		**15**	6.3	64.6	14.54
10/16/07	Y				1			1		3			**5**	5.2	98.0	18.21
10/17/07	Y				4					3	1		**8**	4.6	88.1	16.69
10/18/07	Y				1					2			**3**	5.6	85.8	19.78
10/19/07	Y				2					3			**5**	9.6	80.6	22.27
10/20/07	Y				1								**1**	7.9	55.5	14.24
10/21/07	Y		1		1								**2**	n/a	49.3	16.3
10/22/07	Y												**0**	n/a	98.0	15.3
10/23/07	Y	1			2					5	1		**9**	n/a	97.9	8.6
10/24/07	Y				1						1		**2**	n/a	91.2	6.8
10/25/07	N												n/a	n/a	n/a	n/a
10/26/07	N												n/a	n/a	n/a	n/a
10/27/07	N												n/a	n/a	n/a	n/a
10/28/07	N												n/a	n/a	n/a	n/a
By Species		**1**	**8**	**6**	**104**	**0**	**0**	**3**	**0**	**29**	**71**	**0**	**222**	**n/o indicates detector not operating that night**		
By Guild		**119**				**3**			**0**	**100**						
		BBSHHB				**RBEP**			**MYSP**	**UNKN**			**Total**			

Appendix B Table 5. Summary of acoustic bat data and weather during each survey night at the South Low detector – Fall 2007

		BBSHHB				RBEP			MYSP	UNKN						
Night of	**Operated Okay?**	**big brown bat**	**hoary bat**	**silver-haired bat**	**silver-haired/big brow**	**eastern pipistrelle**	**eastern red bat**	**pipistrelle/red bat**	**MYSP**	**high-frequency**	**low-frequency**	**unknown**	**Total**	**Wind Speed (m/s)**	**Relative Humidity (%)**	**Temperature (celsius)**
8/29/07	Y				1				1	1			**3**	1.6	n/a	29.54
8/30/07	Y				25						12		**37**	2.4	n/a	30.05
8/31/07	Y				12					1	5		**18**	5.5	n/a	22.44
9/1/07	Y									3	2		**5**	6.4	47.3	21.42
9/2/07	Y				2					2			**4**	5.4	45.9	23.98
9/3/07	Y				2					3			**5**	3.1	49.7	25.97
9/4/07	Y				2			1			2		**5**	4.2	34.0	26.87
9/5/07	Y					1					1		**2**	2.6	35.7	28.22
9/6/07	Y												**0**	5.4	45.4	28.51
9/7/07	Y												**0**	4.4	46.5	27.76
9/8/07	Y				1								**1**	6.6	52.5	27.99
9/9/07	N												**n/a**	5.4	48.4	19.91
9/10/07	N												**n/a**	n/a	54.0	n/a
9/11/07	N												**n/a**	2.1	46.5	25.23
9/12/07	N												**n/a**	6.9	85.7	17.66
9/13/07	N												**n/a**	6.4	56.7	15.32
9/14/07	N												**n/a**	5.2	78.7	19.96
9/15/07	N												**n/a**	7.2	77.1	17.61
9/16/07	N												**n/a**	3.7	76.7	9.54
9/17/07	N												**n/a**	4.5	59.4	12.36
9/18/07	N												**n/a**	6.5	58.4	17.22
9/19/07	N												**n/a**	6.7	59.3	19.91
9/20/07	N												**n/a**	2.7	86.1	22.21
9/21/07	N												**n/a**	4.3	64.6	24.28
9/22/07	N												**n/a**	4.5	64.8	24.33
9/23/07	N												**n/a**	6.6	57.8	21.40
9/24/07	N												**n/a**	6.4	64.0	21.15
9/25/07	N												**n/a**	5.8	92.8	25.36
9/26/07	N												**n/a**	6.7	98.6	23.72
9/27/07	N												**n/a**	2.9	89.6	19.44
9/28/07	N												**n/a**	2.8	70.3	15.98
9/29/07	N												**n/a**	5.4	69.5	16.40
9/30/07	N												**n/a**	6.4	51.9	16.41
10/1/07	N												**n/a**	6.7	74.0	20.10
10/2/07	N												**n/a**	7.4	68.9	20.52
10/3/07	N												**n/a**	6.1	80.9	21.27
10/4/07	N												**n/a**	1.4	75.9	20.46
10/5/07	N												**n/a**	4.8	80.9	23.19
10/6/07	N												**n/a**	5.0	73.9	24.31
10/7/07	N												**n/a**	1.4	70.3	24.63
10/8/07	N												**n/a**	0.6	68.3	25.46
10/9/07	N												**n/a**	5.7	65.6	25.91
10/10/07	N												**n/a**	7.0	79.4	18.36
10/11/07	N												**n/a**	4.1	85.1	8.87
10/12/07	N												**n/a**	5.9	81.5	11.44
10/13/07	N												**n/a**	3.8	69.0	7.45
10/14/07	N												**n/a**	5.1	72.4	10.86
10/15/07	N												**n/a**	6.3	64.6	14.54
10/16/07	N												**n/a**	5.2	98.0	18.21
10/17/07	N												**n/a**	4.6	88.1	16.69
10/18/07	N												**n/a**	5.6	85.8	19.78
10/19/07	N												**n/a**	9.6	80.6	22.27
10/20/07	N												**n/a**	7.9	55.5	14.24
10/21/07	N												**n/a**	n/a	49.3	16.3
10/22/07	N												**n/a**	n/a	98.0	15.3
10/23/07	N												**n/a**	n/a	97.9	8.6
10/24/07	N												**n/a**	n/a	91.2	6.8
10/25/07	N												**n/a**	n/a	n/a	n/a
10/26/07	N												**n/a**	n/a	n/a	n/a
10/27/07	N												**n/a**	n/a	n/a	n/a
10/28/07	N												**n/a**	n/a	n/a	n/a
By Species		**0**	**0**	**0**	**45**	**1**	**0**	**1**	**1**	**10**	**22**	**0**	**80**	**n/o indicates detector not operating that night**		
By Guild		**45**				**2**			**1**	**32**						
		BBSHHB				**RBEP**			**MYSP**	**UNKN**			**Total**			

Appendix B Table 6. Period of operation for six Anabat detectors deployed for the Buckeye Wind Project – Fall 2007

Date	North High	NorthLow	NorthTree	SouthHigh	SouthLow	SouthTree
8/28/07	Y	Y	Y	N	N	N
8/29/07	Y	Y	Y	Y	Y	N
8/30/07	Y	Y	Y	Y	Y	N
8/31/07	Y	Y	Y	Y	Y	N
9/1/07	Y	Y	Y	Y	Y	N
9/2/07	Y	Y	Y	Y	Y	N
9/3/07	Y	Y	Y	Y	Y	N
9/4/07	Y	Y	Y	Y	Y	N
9/5/07	Y	Y	Y	Y	Y	N
9/6/07	Y	Y	Y	Y	Y	N
9/7/07	Y	Y	Y	Y	Y	N
9/8/07	Y	Y	Y	Y	Y	N
9/9/07	Y	Y	Y	Y	N	N
9/10/07	Y	Y	Y	Y	N	N
9/11/07	Y	Y	Y	Y	N	N
9/12/07	N	Y	Y	Y	N	N
9/13/07	N	Y	Y	Y	N	N
9/14/07	N	Y	Y	Y	N	N
9/15/07	N	Y	Y	Y	N	N
9/16/07	N	Y	Y	Y	N	N
9/17/07	N	Y	Y	Y	N	N
9/18/07	N	Y	Y	Y	N	N
9/19/07	N	Y	Y	Y	N	N
9/20/07	N	Y	Y	Y	N	N
9/21/07	N	Y	Y	Y	N	N
9/22/07	N	Y	N	Y	N	N
9/23/07	Y	Y	N	Y	N	N
9/24/07	Y	Y	N	Y	N	Y
9/25/07	Y	Y	N	Y	N	N
9/26/07	Y	Y	N	Y	N	N
9/27/07	Y	Y	N	Y	N	N
9/28/07	Y	Y	N	Y	N	N
9/29/07	Y	Y	N	Y	N	N
9/30/07	Y	Y	N	Y	N	N
10/1/07	Y	Y	N	Y	N	N
10/2/07	Y	Y	N	Y	N	Y
10/3/07	Y	Y	N	Y	N	Y
10/4/07	Y	Y	N	Y	N	Y
10/5/07	Y	Y	N	Y	N	Y
10/6/07	Y	Y	N	Y	N	Y
10/7/07	Y	Y	N	Y	N	Y
10/8/07	Y	Y	N	Y	N	Y
10/9/07	Y	Y	N	Y	N	Y
10/10/07	Y	Y	N	Y	N	Y
10/11/07	Y	Y	N	Y	N	Y
10/12/07	Y	Y	N	Y	N	Y
10/13/07	Y	Y	N	Y	N	Y
10/14/07	Y	Y	N	Y	N	Y
10/15/07	Y	Y	N	Y	N	Y
10/16/07	Y	Y	N	Y	N	Y
10/17/07	Y	Y	N	Y	N	Y
10/18/07	Y	Y	N	Y	N	Y
10/19/07	Y	Y	N	Y	N	Y
10/20/07	Y	Y	N	Y	N	Y
10/21/07	Y	Y	N	Y	N	Y
10/22/07	Y	Y	N	Y	N	Y
10/23/07	Y	Y	N	Y	N	Y
10/24/07	Y	N	N	Y	N	Y
10/25/07	Y	N	N	N	N	N
10/26/07	Y	N	N	N	N	N
10/27/07	Y	N	N	N	N	N
10/28/07	Y	N	N	N	N	N
10/29/07	Y	N	N	N	N	N

Appendix C

Raptor survey results

Appendix C Table 1. Summary of daily raptor migration surveys at Buckeye Wind Project in fall 2007

Species	8/30/07	9/11/07	9/13/07	9/18/07	9/19/07	9/28/07	10/2/07	10/3/07	10/4/07	10/10/07	10/11/07	Grand Total
American kestrel			1									1
Black vulture				1						1	1	3
Cooper's hawk	2							1				3
Northern goshawk						1						1
Northern harrier										2		2
Red-tailed hawk	2	1	1	3		1	4		1		1	14
Sharp-shinned hawk	1		2			1						4
Turkey vulture	34	18	53	39	50	64	67	23	19	5	8	380
Unidentified raptor										7	5	12
Unidentified accipiter										1		1
Grand Total	39	19	57	43	50	67	71	24	20	16	15	421

Appendix C Table 2. Summary of hourly raptor observations at Buckeye Wind Project in fall 2007

Species	9:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00	Grand total
American kestrel						1	1
Black vulture				2	1		3
Coopers hawk	1			1		1	3
Northern goshawk	1						1
Northern harrier	1			1			2
Red-tailed hawk	4	1	3	4	2		14
Sharp-shinned hawk			1	1	2		4
Turkey vulture	45	93	69	69	70	34	380
Unidentified accipiter			1				1
Unidentified raptor	5	2	2	1	1	1	12
Grand total	57	96	76	79	76	37	421

Appendix C Table 3. Flight height distribution of raptors observed during fall surveys at the Buckeye Wind Project, fall 2007

SPECIES	**Flight Height**				
	< 125 m	**> 125 m**	**< 150 m**	**> 150 m**	**Total**
American kestrel	1		1		**1**
Black vulture	3		3		**3**
Cooper's hawk	2	1	3		**3**
Northern goshawk	1		1		**1**
Northern harrier	2		2		**2**
Red-tailed hawk	7	7	8	6	**14**
Sharp-shinned hawk	3	1	3	1	**4**
Turkey vulture	296	84	318	62	**380**
Unidentified accipiter	1		1		**1**
Unidentified raptor	12		12		**12**
Total	**328**	**93**	**352**	**69**	**421**

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Appendix C Table 4. Summary of regional fall 2007 migration surveys in relation to the results of the Buckeye Wind Project raptor survey

Site Number [1]	Location	Survey Period - Fall 2007	Survey Hours	BV	TV	OS	BE	NH	SS	CH	NG	RS	BW	RT	RL	GE	AK	ML	PG	UA	UB	UF	UE	UR	Total	Birds/ Hour
1	Waggoner's Gap, PA	Aug 1 - Dec 18	1089.5	72	1369	658	327	443	9720	1110	91	260	6957	3873	5	209	393	138	72	73	21	9	3	98	25,901	23.8
2	Hawk Mountain, PA	Aug 13 - Dec 18	1066.3	140	636	717	239	279	5099	750	43	223	7836	2410	4	106	526	232	38	56	31	18	0	52	19,437	18.2
3	Kittatinny Mountain, NJ	Sept 3 - Nov 8	258.8	0	0	121	31	40	683	91	1	16	746	174	0	0	118	21	8	14	6	10	0	46	2,126	8.2
4	Franklin Mountain, NY	Aug 18 - Dec 18	795.8	0	483	140	138	109	835	162	25	93	1639	2141	10	163	89	38	25	7	5	1	0	48	6,151	7.7
5	Lake Erie, Metro Park, MI	Sept 1 – Nov 30	598	0	62882	195	211	818	9909	724	6	1026	69574	9406	29	124	1275	41	67	0	0	0	0	8	156,295	261.4
6	Hanging Rock, WV	Aug 18 - Nov 18	266	0	0	34	42	16	317	88	3	7	1725	361	1	17	39	3	2	9	5	1	2	1	2,673	10
7	Stone Mountain, PA	Sept 1 - Dec 4	338	19	93	97	57	79	943	211	11	66	986	1624	0	107	74	27	16	1	1	0	0	84	4,497	13.3
8	Bear Mountain Farm, VA	Sept 1 - Oct 30	70.9	0	5	8	23	11	52	7	0	13	256	11	0	6	17	0	0	8	2	1	3	30	453	6.4
9	Snickers Gap, VA	Aug 26 - Dec 1	348.5	0	0	184	224	168	1653	267	12	150	8110	1625	0	17	133	46	21	21	16	4	0	22	12,674	36.4
10	Hawk Cliff, ON	Aug 31 – Dec 8	615.3	0	21315	209	406	2116	16643	637	34	1134	41018	11148	43	151	4431	265	148	3	7	2	1	6	99,717	162.1
11	Holiday Beach, ON	Sept 1 – Nov 30	635.5	0	31339	186	175	1280	12389	730	16	509	18400	6470	20	79	1611	108	95	4	38	4	0	7	73,460	115.6
12	Tuscarora Summit, PA	Sept. 4 - Nov 14	297.8	2	195	90	30	85	1017	88	3	23	724	631	1	20	26	8	17	23	8	8	0	42	3,041	10.2
13	Jacks Mountain, PA	Aug 24 - Nov 5	190	7	103	45	26	28	650	58	1	9	1878	374	0	7	37	11	7	1	1	0	0	3	3,246	17.1
14	Little Gap, PA	Aug 15 - Nov 25	551.8	88	579	478	141	178	3636	475	41	86	7231	1422	0	52	198	76	33	18	21	7	1	96	14,857	26.9
15	*Buckeye Wind, OH*	*Aug 30 – Oct 11*	*66*	*3*	*380*	*0*	*0*	*2*	*4*	*3*	*1*	*0*	*0*	*14*	*0*	*0*	*1*	*0*	*0*	*1*	*0*	*0*	*0*	*12*	*421*	*6.4*

[1] Refer to Figure 4-2 for raptor survey location. Sites 1-14 reflect Hawk Migration Association of North America (HMANA) count data.
HMANA collects hawk count data from almost two hundred affiliated raptor monitoring sites throughout the United States, Canada, and Mexico.
The HMANA count data used to construct this table included unusual species, such as Swainson's hawks and gyrfalcons. These numbers were not incorporated here.

Abbreviation Key:

BV - Black vulture	RL - Rough-legged hawk
TV - Turkey vulture	GE - Golden eagle
OS - Osprey	AK - American kestrel
BE - Bald eagle	ML - Merlin
NH - Northern harrier	PG – Peregrine falcon
SS - Sharp-shinned hawk	UA – Unidentified accipiter
CH - Cooper's hawk	UB – Unidentified buteo
NG - Northern goshawk	UF – Unidentified falcon
RS - Red-shouldered hawk	UE – Unidentified eagle
BW - Broad-winged hawk	UR – Unidentified raptor
RT - Red-tailed hawk	

Appendix C Table 5. Summary of available fall diurnal raptor survey results

Project Site	Survey Period	# of Survey Days	# of Survey Hours	Landscape	Total # Observed	# of Species Observed*	Ave. Passage Rate (Raptors/Hr)	(Turbine Ht) % Raptors Below Turbine Height	Citation
Fall 1996									
Searsburg, Bennington County, VT	9/11 - 11/3	20	80	Forested ridge	430	12	5.4	n/a	Kerlinger 1996
Fall 1998									
Harrisburg, Lewis County, NY	9/2 -10/1	13	68	Great Lakes plain/ADK foothills	554	12	8.1	n/a (47 m mean flight height)	Cooper & Mabee 2000
Wethersfield, Wyoming Cty, NY	9/2 - 10/1	24	107	Agricultural plateau	256	12	2.4	n/a (48 m mean flight height)	Cooper & Mabee 2000
Fall 2004									
Prattsburgh, Steuben Cty, NY	9/2- 10/28	13	73	Agricultural plateau	220	10	3.0	(125 m) 62%	Woodlot 2005b
Cohocton, Stueben, Cty, NY	9/2 - 10/28	8	41	Agricultural plateau	128	8	3.1	(125 m) 80%	Woodlot 2005u
Deerfield, Bennington Cty, VT (Existing Facility)	9/2 - 10/31	10	60	Forested ridge	147	11 for sites combined	2.5	(100 m) 9% for sites combined	Woodlot 2005c
Deerfield, Bennington Cty, VT (Western Expansion)	9/2 - 10/31	10	57	Forested ridge	725	11 for sites combined	12.7	(100 m) 9% for sites combined	Woodlot 2005c
Sheffield, Caledonia Cty, VT	9/11 - 10/14	10	60	Forested ridge	193	10	3.2	(125 m) 31%	Woodlot 2006a
Fall 2005									
Cohocton, Stueben, Cty, NY	9/7 - 10/1	7	40	Agricultural plateau	131	10	3.3	(125) 63%	Woodlot 2005u
Churubusco, Clinton Cty, NY	10/6- 10/22	10	60	Great Lakes plain/ADK foothills	217	15	3.6	(120 m) 69%	Woodlot 2005l
Dairy Hills, Clinton Cty, NY	9/11 - 10/10	4	16	Agricultural plateau	48	7	3.0	n/a	Young *et al.* 2006
Howard, Steuben Cty, NY	9/1 - 10/28	10	57	Agricultural plateau	206	12	3.6	(91 m) 65%	Woodlot 2005o
Fall 2005									
Munnsville, Madison Cty, NY	9/6 - 10/31	11	65	Agricultural plateau	369	14	5.7	(118 m) 51%	Woodlot 2005r
Mars Hill, Aroostook Cty, ME	9/9 - 10/13	8	43	Forested ridge	115	13	1.5	(120 m) 42%	Woodlot 2005t
Lempster, Sullivan County, NH	Fall 2005	10	80	Forested ridge	264	10	3.3	(125 m) 40%	Woodlot 2007c
Clayton, Jefferson Cty, NY	9/9 - 10/16	11	64	Agricultural plateau	575	13	9.1	(150 m) 89%	Woodlot 2005m
Fall 2006									
Stetson, Penobscot Cty, ME	9/14 - 10/26	7	42	Forested ridge	86	11	2.1	(125 m) 63%	Woodlot 2007b
Fall 2007									
Champaign and Logan Ctys, OH	*8/30 - 10/11*	*11*	*66*	*Agricultural plateau*	*421*	*8*	*6.4*	*(125) 78%; (150) 84%*	*n/a*

Spring, Summer, and Fall 2008 Bird and Bat Survey Report

for the Buckeye Wind Power Project

in Champaign and Logan Counties, Ohio

Prepared for

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February 2009

Executive Summary

This report has been prepared to summarize results of spring, summer, and fall 2008 avian and bat surveys conducted by Stantec Consulting (Stantec) to characterize activity of birds and bats in the vicinity of the proposed Buckeye Wind facility in Champaign and Logan Counties, Ohio (Project). The surveys are part of the planning process by EverPower Wind Holdings, Inc. (EverPower) for a proposed wind project, which will include erection of a wind farm located primarily on open agricultural lands.

These surveys represent the second year of investigation undertaken at this site. Pre-construction assessments of the Project area began in fall 2007 when Stantec conducted nocturnal radar, raptor migration, and bat acoustic surveys. To further characterize use of the Project area by birds and bats, Stantec conducted acoustic bat, diurnal raptor, breeding bird, and hibernacula/swarm surveys in 2008, the results of which will be the basis of discussion for this report. The results of these field surveys provide useful information about site-specific migration patterns and breeding activities in the vicinity of the Project, especially when considered along with the results from the 2007 surveys.

Passive Acoustic Bat Survey

Acoustic bat surveys were conducted from March 29 through September 3, 2008 using six Anabat detectors. Two detectors were deployed in each of two meteorological (met) towers in the Project area at two different heights (high [40 meters {m}; 131 feet {ft}], low [20 m; 66 ft]). One detector was deployed in a tree within the met tower clearing at approximately ground-level [2 m; 7 ft]) at each of the met towers, for a total of six bat detectors. The habitat surrounding both met towers was open agriculture or pasture, with scattered hedgerows and isolated trees. Recordings of acoustic bat call sequences occurred on 774 of 954 potential detector-nights (81% success rate). Individual detector success ranged from 69% to 95% for the total survey period.

A total of 18,715 bat calls sequences were recorded during the March through September survey period, with a mean nightly detection rate of 23.9 call sequences/detector/night (s/d/n) for the entire survey period. Number of nightly detections varied from 0 to 688 across detectors. Detection rates were generally higher at north met tower detectors than at south met tower detectors. Mean nightly detection rate was variable across seasons, with the highest rates recorded during the fall sampling period (August 15 to September 3) at all detectors except the South Tree detector.

Bat call sequences were identified to the lowest possible taxonomic level and were grouped into five guilds based on similarity in call characteristics between species. The majority of the recorded bat call sequences (60%) were identified as the BBSH (big brown/silver-haired bat) guild, followed by those identified to the UNKN (unknown) guild (32%), the RBTB (red/tri-colored bat) guild (4%), the MYSP (*Myotis*) guild (3%), and the HB (hoary bat) guild (1%). Throughout the survey period, bat activity was highest one to two hours after sunset and declined thereafter.

Based on qualitative analysis of the average number of call sequences recorded during spring, summer, and fall 2008, a possible relationship existed between average nightly temperature and bat activity, such that the number of call sequences recorded remaining relatively low at temperatures less than 10 ºC (50 ºF). Activity also appeared to be related to wind speed, with few calls sequences recorded at wind speeds greater than 7.5 m/s (16.8 mph).

When comparing detection rates in the Project area to other wind project sites for which data are publicly available, average detection rates at the four met tower detectors (1.8 s/d/n in spring; 12.4 s/d/n in fall) were within the range of those recorded during acoustic surveys at other wind project sites in the east in recent years. While the average detection rate recorded at the two tree detectors (17.7 s/d/n) during the spring was also similar to rates observed at other wind project sites, an exceptionally high number of calls recorded at the North Tree detector (256.5 s/d/n) accounted for a high average detection rate at tree detectors during the fall (128.0 s/d/n). The call sequences recorded at the North Tree detector during the fall were mostly identified to the BBSH guild (74%; n=3228), with the majority likely produced by big brown bats. Thus, it is likely that the North Tree detector was placed in close proximity to a big brown maternity colony.

Raptor and Sandhill Crane Migration Survey

Diurnal surveys were conducted to document raptor species and sandhill cranes (*Grus canadensis*) migrating through the Project area, as well as behavioral characteristics such as flight altitude and direction relative to the Project area. Thirty-two days (216 hours) of raptor surveys were conducted from March 1 to May 15, 2008, and again for 24 days (167 hours) from September 1 to November 15, 2008. Sandhill crane surveys occurred on 12 days (84 hours) from November 16 to December 15, 2008. All surveys were conducted on an open hillside in the central portion of the Project area near a communication tower which provided a reference for determining raptor flight altitudes.

A total of 1,476 raptors representing twelve species were observed in the spring, yielding an observation rate of 6.8 birds/hour. A total of 581 raptors representing seven species were observed during the fall, yielding an observation rate of 3.5 birds/hour. During the sandhill crane survey, 27 raptors representing six species were observed, yielding an observation rate of 0.3 birds/hour during this period. No federally threatened or endangered species were observed during the survey period. Four raptor species observed during the survey are listed by the Ohio Department of Natural Resources: the northern harrier (*Circus cyaneus*) is state-listed as endangered, the peregrine falcon and bald eagle are state-listed as threatened, and the sharp-shinned hawk (*Accipiter striatus*) is a state species of concern. Although no sandhill cranes were observed from November 15 to December 15, four sandhill cranes, a state endangered species, were observed during a raptor survey on March 6, 2008.

The majority (spring n=1,347, 91%; fall n=527, 91%) of raptors observed during the survey period were turkey vultures (*Carthartes aura*). Red-tailed hawks (*Buteo jamaicensis*) were the second most commonly observed species, accounting for 7% of the total observations (n=98) in the spring, and 6% (n=32) in the fall. The majority of raptors (95% in spring and 93% in fall) were observed flying below 150 m. However, migrating raptor numbers were relatively low compared to other regional hawk counts, and raptors do not appear to concentrate within the Project area.

Breeding Bird Survey

A breeding bird survey (BBS) was conducted in spring 2008 to document the use of the Project area by breeding birds. One round of surveys was conducted in May, two rounds were conducted in June and early July, and one was conducted in July. Surveys consisted of 90 10-minute point count surveys positioned throughout the Project area in agricultural or forested habitat in one control plot and two treatment plots. Point count surveys documented a total of 97 species. The habitat with the greatest species richness (SR =39) and relative abundance (RA=7.67) in the control plot was forested habitat. The habitat with the greatest species richness (SR=47) and relative abundance (RA=9.22) in the treatment plots was agricultural habitat.

No federally endangered or threatened species were detected in the Project area during the spring 2008 breeding bird surveys. One state endangered species, the northern harrier, was detected, and one state threatened species, the least flycatcher (*Empidonax minimus*), was detected. Two state species of concern were detected: the bobolink (*Dolichonyx oryzivorus*) and the northern bobwhite (*Colinus virginianus*). Two state species of special interest were also detected: the magnolia warbler (*Dendroica magnolia*) and the blackburnian warbler (*Dendroica fusca*).

Hibernacula and Fall Swarm Survey

Stantec conducted a hibernacula survey in late winter 2008 and a swarm survey in fall 2008 to document the species composition and number of bats using Sanborn's Cave/Streng Cave and another nearby, unnamed cave in the Project area. In addition to these caves, 11 potential or documented karst locations, identified by the ODNR's Natural Areas Program (DNAP) were evaluated for use by bats. Of the 11 potential karst features surveyed, only one had evidence of karst geology, and no openings were discovered.

A hibernacula survey was conducted on March 4, 2008 at Sanborn's Cave and the nearby, unnamed cave. Only a partial survey of Sanborn's Cave and the unnamed cave were conducted due to landowner access restrictions or cave entry related safety issues. Only four tri-colored bats (*Perimyotis subflavus*) were observed on the ceiling of Sanborn's Cave during the partial survey of the cave. Biologists were not able to get far enough into the interior of the unnamed cave to document the presence of any hibernating bats.

Swarm surveys were conducted at both cave openings in fall 2008. A total of 884 bats were captured using harp traps and mist-nets during five swarm surveys at both cave openings on

September 15 (365 bats captured), September 24 (168 bats captured), October 6 (244 bats captured), October 20 (99 bats captured), and October 27 (8 bats captured). Three species were captured in harp traps: tri-colored bats, little brown bats (*Myotis lucifugus*), and northern long-eared bats (*Myotis septentrionalis*). Big brown bats (*Eptesicus fuscus*) were captured only in mist-nets placed over a stream during the September 15 survey.

Northern long-eared bats were the most common species captured at the cave openings (74%; n= 653), with males representing 58% of all northern long-eared bats captured. The second most frequently captured species was the little brown bat, representing 23% (n= 201) of all bats captured. Males represented the majority (82%) of all little brown bats captured. The least frequently captured bats were tri-colored bats (n=18; 2%) and big brown bats (n=12; 1%).

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PN195600164

1.0 Introduction

This report has been prepared to summarize results of spring, summer, and fall 2008 avian and bat surveys conducted by Stantec Consulting (Stantec) to characterize activity of birds and bats in the vicinity of the proposed Buckeye Wind facility (Project). Following is a brief description of the Project, a review of methods used to conduct scientific surveys and their results, and a brief discussion of the implications of survey results.

1.1 PROJECT CONTEXT

EverPower Wind Holdings, Inc. (EverPower) has proposed to develop a wind power facility in central Ohio, in Champaign County. The facility would include construction of turbine towers and pads, transmission lines, and access roads. The Project was originally proposed to be located on approximately 21,756 hectares (53,760 acres) of privately owned, predominantly agricultural lands near the towns of Mutual, Mechanicsburg, Mingo, Woodstock, and North Lewisburg. The first phase of the Project is still in the preliminary stages of design, but is expected to consist of 70 turbines, meteorological (met) towers and associated access roads, transmission lines, and an electrical substation. The turbines will likely be 1.8 to 2.5 megawatt (MW) machines mounted on tubular steel towers. The height specifications of proposed turbines have not yet been determined, but turbines are expected to have a maximum height of 150 meter (m; 492 feet [ft]; 100 m hub height with 50 m blade length).

In advance of permitting activities for the Project, EverPower contracted Stantec to conduct wildlife surveys to provide data to help assess the potential impacts to birds and bats from the proposed Project. Pre-construction assessments of the Project area began in fall 2007 when Stantec conducted nocturnal radar, raptor migration, and bat acoustic surveys. To further characterize use of the Project area by birds and bats, Stantec conducted acoustic bat, diurnal raptor, breeding bird, and hibernacula/swarm surveys in 2008, the results of which will be the basis of discussion for this report.

This document and all field surveys conducted in support of this document, are in accordance with the work plan that was developed cooperatively and approved by the Ohio Department of Natural Resources (ODNR) and the Reynoldsburg Ohio Ecological Services Field Office of the Unites States Fish and Wildlife Service (OH USFWS) in May 2008. Surveys were also conducted in accordance with standard methods that are developing within the wind power industry and are consistent with the survey protocols approved for several other wind energy projects conducted recently in the eastern region of the United States.

1.2 PROJECT AREA DESCRIPTION

The Project area (Figure 1-1) is a mosaic of active agricultural lands, mostly corn and soybean, interspersed with relatively small stands of mixed hardwood forest. It lies on an approximately 396 m (1,300 ft) plateau that rises 91 to 152 m (300 to 500 ft) above the surrounding landscape.

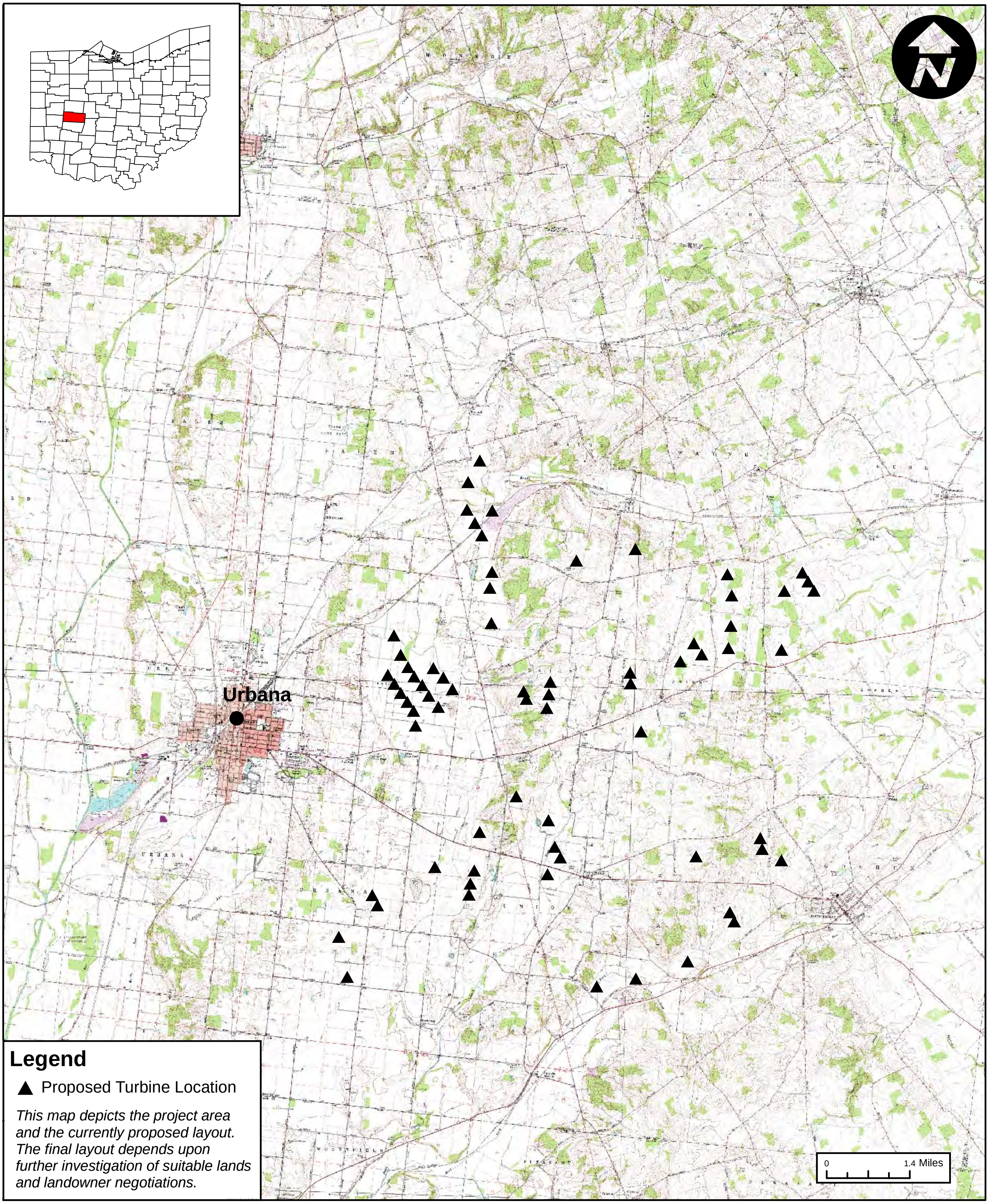
The local topography is characterized by small rolling hills. Many areas are underlain by karst geological features, or those formed by the dissolution of layers of soluble bedrock that creates subterranean drainages and sinkholes. The northern portion of the study area has more karst topography features and a greater density of woodlots bordering agricultural fields than the southern portion. Land use in the area includes active agricultural operations, low density residential developments, and some tourist activity at historical sites.

The area is comprised of predominantly agricultural habitat, with scattered areas of upland and riparian forests, as well as shrub habitats. Forested habitat that supports water features such as streams comprises 1,640 hectares (4,052 acres) or 7% of the total Project area. Most of the forest stands are mixed hardwood dominated by oaks (*Quercus* spp.), maples (*Acer* spp.), hickories (*Carya* spp.), and ash (*Fraxinus* spp.), with few conifer trees. Many forest stands are even-aged, while some are more structurally diverse. Many stands contain both live and dead trees and provide potential habitat for birds and bats. The majority, if not all, of the turbines currently proposed are to be located in open agricultural settings.

1.3 SURVEY OVERVIEW

Stantec conducted field investigations, or surveys, for bird and bat migration during spring, summer, and fall 2008. The overall goals of the surveys were to document:

- activity patterns of bats in the Project area, including the seasonal peaks in detections rate, guild and species composition, and relationship with weather factors;
- passage rates for diurnal raptor and sandhill crane (*Grus canadensis*) migration in the vicinity of the Project area, including the number and species of migrants, their flight direction, and their flight altitude;
- species composition and abundance of breeding birds within the Project area, and where possible, the presence of any rare, threatened, or endangered species; and
- species composition and abundance of bats swarming and/or hibernating within the Project area.



Legend

▲ Proposed Turbine Location

This map depicts the project area and the currently proposed layout. The final layout depends upon further investigation of suitable lands and landowner negotiations.

Prepared By: Stantec	*Sheet Title:* Project Area Location Map	*Date:* February 2009
		Scale: 1" = 2.2 Miles
		Proj. No.: 195600164
	Project: Buckeye Wind Power Project, Ohio © EverPower Wind Holdings, Inc.	*Figure:* 1-1

2.0 Acoustic Bat Survey

2.1 INTRODUCTION

Stantec conducted passive acoustic surveys during spring, summer, and fall 2008 to supplement 2007 acoustic survey efforts. The goal of spring and fall acoustic surveys was to document migratory bat activity patterns in the proposed Project area, and the goal of the summer survey was to document bat activity in the Project area during the breeding season. Acoustic bat detectors allow for passive and long-term monitoring of bat activity in a variety of habitats, including the air space approaching the rotor-swept zone of modern wind turbines. The acoustic bat survey conducted at the Project was designed to document bat activity patterns near the rotor zone of the proposed turbines, at an intermediate altitude, and near the ground. Acoustic surveys were also intended to document bat activity patterns in relation to weather factors including wind speed, temperature, and relative humidity.

A total of eleven bat species known to occur in the state of Ohio, based on their normal geographic ranges, have potential to be documented in acoustic surveys. These include *Mytois* species: Indiana bat (*Myotis sodalis*), little brown bat (*M. lucifugus*), northern long-eared bat (*M. septentrionalis*), eastern small-footed bat (*M. leibii*); as well as other Microchiroptera species: silver-haired bat (*Lasionycteris noctivagans*), tri-colored bat (*Perimyotis subflavus*)[1], big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), hoary bat (*L. cinereus*), evening bat (*Nycticeius humeralis*), and Rafinesque's big-eared bat (*Corynorhinus rafinesquii*). Of these, the Indiana bat is listed as a federally endangered species, and the eastern small-footed bat and the Rafinesque's big-eared bat are listed as state-endangered by the ODNR. Although the Project area is slightly north of Rafinesque's big-eared bat's normal distribution, there is some potential for its occurrence in the vicinity of the Project area.

2.2 METHODS

2.2.1 Field Surveys

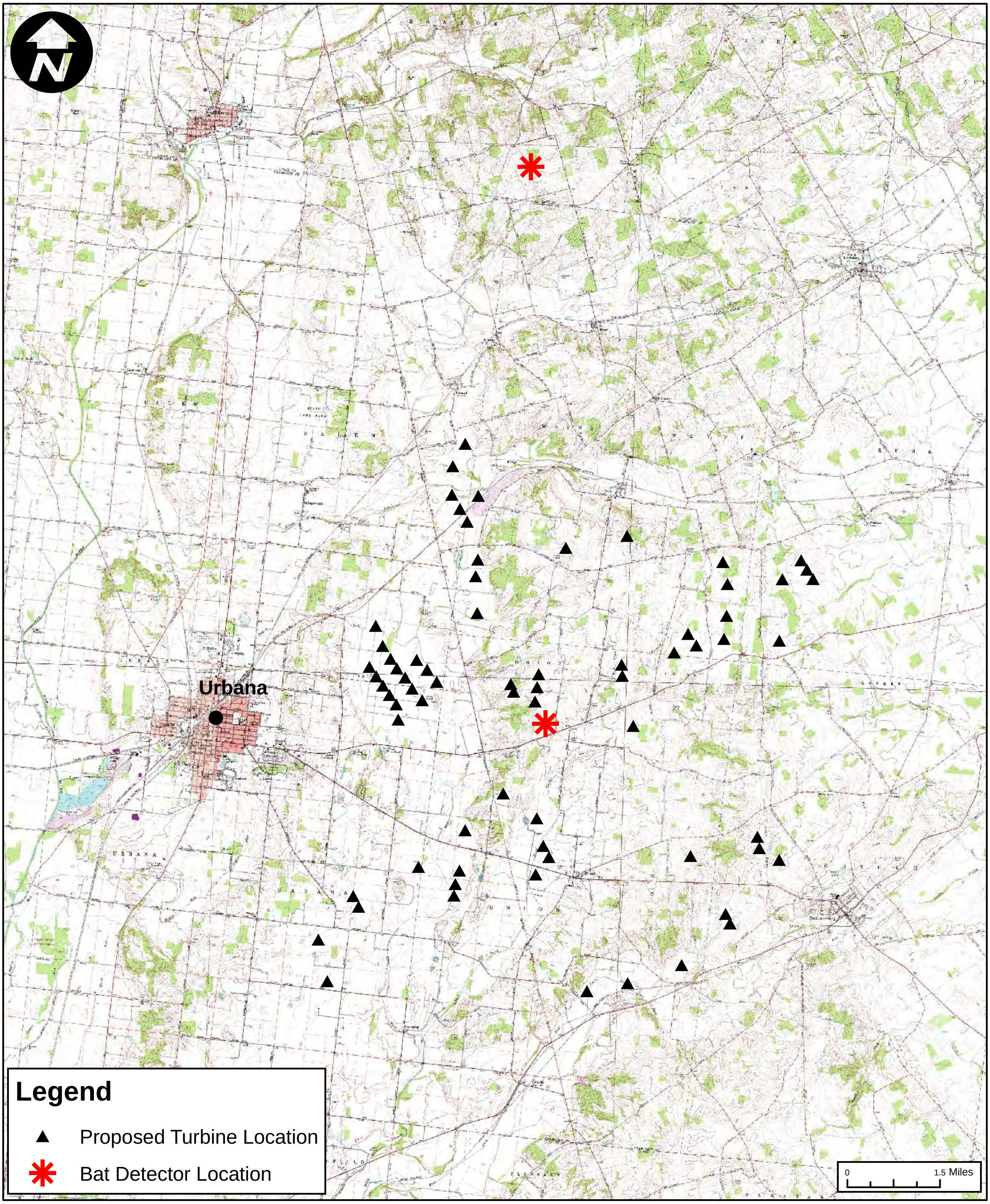
Anabat SD1 and Anabat II detectors (Titley Electronics Pty Ltd.) were used to record bat echolocation calls. Anabat detectors were selected based upon their widespread use for this type of survey, their ability to be deployed for long periods of time, and their ability to detect a broad frequency range which allows detection of all species of bats that could occur in the Project area. Anabat detectors are frequency division detectors that divide the frequency of ultrasonic calls made by bats by a factor of 16 so that they are audible to humans, and then record the calls for subsequent analysis. The audio sensitivity setting of each Anabat system was set at between six and seven (on a scale of one to ten) to maximize sensitivity while limiting ambient background noise and interference. The sensitivity of individual detectors was then tested using an ultrasonic Bat Chirp (Reno, NV) to ensure that the detectors would be able to

[1] The common and scientific name of the tri-colored bat was recently changed from eastern pipistrelle (*Pipistrellus subflavus*).

detect bats to a minimum distance of at least 10 m (33 ft). Each Anabat detector was coupled with CF Storage ZCAIMs (Titley Electronics Pty Ltd.), which programmed the detector to record from a half hour before sunset to a half hour after sunrise. Data were stored on removable 1 GB compact flash cards.

Detectors were powered by 12-volt batteries charged by solar panels. Each solar-powered Anabat system was deployed in a waterproof housing enabling the detector to record while unattended for the duration of the survey. The housing directed the Anabat microphone downward to give maximum protection from precipitation. To compensate for the downward position, a reflector shield of smooth plastic was placed at a 45-degree angle directly below the microphone. The angled reflector allowed the microphone to record the airspace horizontally surrounding the detector and was only slightly less sensitive than an unmodified Anabat unit. Maintenance visits were conducted approximately every one to two weeks to check on the condition of the detectors and to download data to a computer for analysis.

Six detectors were deployed in the Project area and were programmed to passively record from a half hour before sunset until a half hour after sunrise from March 29 through September 3, 2008. Three detectors were deployed at each of the two 60 m (197 ft) met towers and were positioned to record calls of bats flying within and adjacent to the met tower clearings. One met tower was located in the northern portion of the Project area (Figures 2-1 and 2-2) and another was located approximately nine miles due south in the southern portion of the Project area (Figures 2-1 and 2-3). The habitat surrounding the met towers was mostly open agriculture or pasture, with scattered hedgerows and isolated trees. Both towers were within 100 to 200 m (328 to 656 ft) of mixed hardwood, second-growth forest stands.



Prepared By:

Stantec

Sheet Title:

Bat Acoustic Survey Location Map

Project:

Buckeye Wind Power Project, Ohio

Date: February 2009

Scale: 1" = 2.1 Miles

Proj. No.: 195600164

Figure:

2-1

Figure 2-2. View looking northwest from the north meteorological tower

Figure 2-3. View looking south from the south meteorological tower

Detectors at each met tower were placed in the following locations: ‘high’ detectors were deployed at a height of approximately 40 m (131 ft) in met towers; ‘low’ detectors were positioned at a height of 20 m (66 ft); and ‘tree’ detectors were placed in nearby trees approximately 1.5 to 3 m (5 to 10 ft) above the ground at the base of the met towers. The individual detectors will be referred to as “North High”, “North Low”, ”North Tree”, ”South High”, ”South Low”, and “South Tree” throughout this report.

2.2.2 Data Analysis

Potential call files were extracted from data files using CFCread© software which screens all data recorded by the bat detector and extracts call files using a filter. A call is a single pulse of sound produced by a bat. A call sequence is a combination of two or more pulses recorded in a call file. The default settings for CFCread© were used during this file extraction process, as these settings are recommended for northeastern bats and they increase comparability between data sets. Settings used by the filter include a max TBC (time between calls) of 5 seconds, a minimum line length of 5 milliseconds, and a smoothing factor of 50. The smoothing factor refers to whether or not adjacent pixels can be connected with a smooth line. The higher the smoothing factor, the less restrictive the filter is and the more noise files and poor quality call sequences (sequences) are retained within the data set. Understanding the parameters of these settings is important in terms of determining when individual calls are classified as “unknown”.

Following extraction of call files, each file was visually inspected to ensure that files created by static or some other form of interference that were still within the frequency range of Ohio bats were not included in the data set. Bat calls typically include a series of pulses characteristic of normal flight or prey location (“search phase” calls) and capture periods (feeding “buzzes”). Bat calls look very different than static, which typically forms a diffuse band of dots at either a constant frequency or widely varying frequency, caused by wind, vibration, or other interference. Using these characteristics, bat call files are easily distinguished from non-bat files.

Bat call sequences were individually marked and categorized by species group, or “guild” based on visual comparison to reference calls. Qualitative visual comparison of recorded call sequences of sufficient length to reference libraries of bat calls allows for relatively accurate identification of bat species (O’Farrell *et al*. 1999, O’Farrell and Gannon 1999). A call sequence was considered of suitable quality and duration if the individual call pulses were “clean” (i.e., consisting of sharp, distinct lines) and at least five pulses were included within the sequence. Call sequences were classified to species whenever possible, based on criteria developed from review of reference calls collected by Chris Corben, the developer of the Anabat system, and other bat researchers. However, due to similarity of call signatures between several species, all classified calls have been categorized into five guilds for presentation in this report. This classification scheme has been modified from Gannon *et al.* (2003) as follows:

- **Unknown (UNKN)** – All call sequences with too few pulses (less than five) or of poor quality (such as indistinct pulse characteristics or background static). These calls were further identified as either “high frequency unknown” (HFUN) for call fragments with a minimum frequency above 30 to 35 kHz; or “low frequency unknown” (LFUN) calls for call fragments with a minimum frequency below 30 to 35 kHz.

- **Myotid (MYSP)** – All four species of *Myotis* potentially occurring in the Project area: little brown bat, northern long-eared bat, eastern small-footed bat, and Indiana bat. Of these species, the little brown bat and northern long-eared bat have calls that tend to be slightly more distinguishable using the Anabat system. While there are some general characteristics believed to be distinctive for several of the species in this genus, these characteristics do not occur consistently enough for any one species to be relied upon at all times when using Anabat recordings.

- **Red bat/tri-colored bat (RBTB)** – Eastern red bats and tri-colored bats. Eastern red bats have relatively unique calls which span a wide range of frequency and have a characteristic hooked shape and variable minimum frequency. Tri-colored bats tend to have relatively uniform calls, with a constant minimum frequency and a sharply curved profile. These two species can produce calls distinctive only to each species. However, significant overlap in the call pulse shape, frequency range, and slope can also occur. This guild would include evening bats if they occurred in the Project area.

- **Big brown/silver-haired/hoary bat (BBSH)** – Big brown and silver-haired bats. Calls of silver-haired bats and big brown bats are occasionally distinguishable, but often overlap in range and can be difficult to distinguish, especially when comparing short duration calls typical of those recorded during passive monitoring. These species’ call signatures commonly overlap and have therefore been included as one guild in this report.

- **Hoary bat (HB)** – Hoary bats. The hoary bat has easily distinguishable calls characterized by highly variable minimum frequencies, often extending below 20 kHz, and a hooked profile similar to the eastern red bat.

This method of guild grouping is a conservative approach to bat call identification. Bat calls were identified to guild within this report, although calls were provisionally categorized by species when possible during analysis. Certain species, such as the eastern red bat and hoary bat have easily identifiable calls; whereas other species, such as the big brown bat and silver-haired bat are difficult to distinguish acoustically. Similarly, certain members of the *Myotis* genus, such as the northern long-eared bat, are far more common and have slightly more distinguishable calls than other species.

Since some species sometimes produce calls unique only to that species, calls were identified to the lowest possible taxonomic level before being grouped into the listed guilds. Tables and figures in the body of this report will reflect those guilds. However, since species-specific identification did occur in some cases, each guild will also be briefly discussed with respect to potential species composition of recorded call sequences. Once all of the call files were identified and categorized in appropriate guilds, nightly tallies of detected calls were compiled. Mean detection rates (number of call sequences/detector-night) for the entire sampling period were calculated for each detector and for all detectors combined.

2.2.3 Weather Data

Weather data was collected at 10-minute intervals by instruments placed in the north and south met towers by EverPower. The 10-minute sample data were averaged to derive nightly estimates of temperature and wind speed, which were then qualitatively compared with numbers of bat call sequences recorded at each detector.

2.3 RESULTS

2.3.1 Detector Operation

Detectors were operational for a total of 774 of 954 potential detector-nights (81%) between March 29 and September 3, 2008 (Table 3-1). Each detector recorded a large quantity of data, and some of the detectors experienced data loss due to occasional power-down or other unexpected technical problems. Detector success ranged from 69% at the North Tree detector, to 95% at the South Tree detector. Data loss in this survey is not considered to be of significant concern because there was always at least one detector functioning at both the north and south sample locations at all times during the survey (Appendix A; Tables 1-6).

2.3.2 Detection Rates

A total of 18,715 bat calls sequences were recorded at the six bat detectors, with a mean nightly detection rate of 23.8 call sequences/detector/night (s/d/n; Tables 2-1 and 2-2) for the entire survey period. Mean nightly detection rate was variable for individual detectors (Table 2-1), with the highest mean detection rate recorded at the North Tree detector (108.3 s/d/n for the entire survey). Detection rates at the four detectors suspended from the met towers ranged from 0.2 s/d/n (South High - spring) to 24.3 s/d/n (North Tree - fall). Detection rates at the two tree detectors ranged from 12.5 s/d/n (North Tree - spring) to 256.5 s/d/n (North Tree -fall). Number of nightly detections varied from 0 to 688 across detectors (Figures 2-4 through 2-8; Appendix A, Tables 1 through 6).

Table 2-1. Seasonal summary of 2008 acoustic survey results at Buckeye Anabat detectors

Detector / Season*	Dates	Number of Nights	Detector-nights**	Sequences Recorded	Detection Rate ***	Max Recorded****
North High						
Spring	29 Mar–15 May	48	25	24	1.0	7
Summer	16 May–15 Aug	92	85	158	1.9	6
Fall	16 Aug–3 Sep	19	19	90	4.7	14
North Low						
Spring	29 Mar–15 May	48	24	66	2.8	13
Summer	16 May–15 Aug	92	85	778	9.2	26
Fall	16 Aug–3 Sep	19	19	461	24.3	46
North Tree						
Spring	29 Mar–15 May	48	24	300	12.5	94
Summer	16 May–15 Aug	92	69	7251	105.1	688
Fall	16 Aug–3 Sep	19	17	4361	256.5	682
South High						
Spring	29 Mar–15 May	48	13	2	0.2	1
Summer	16 May–15 Aug	92	79	259	3.3	14
Fall	16 Aug–3 Sep	19	19	123	6.5	16
South Low						
Spring	29 Mar–15 May	48	48	108	2.3	9
Summer	16 May–15 Aug	92	92	477	5.2	22
Fall	16 Aug–3 Sep	19	19	265	13.9	33
South Tree						
Spring	29 Mar–15 May	48	47	957	20.4	204
Summer	16 May–15 Aug	92	85	2787	32.8	480
Fall	16 Aug–3 Sep	19	19	248	13.1	95
Overall Results						
Spring Met Average	29 Mar–15 May	48	28	50	**1.8**	--
Spring Tree Average		96	71	1257	**17.7**	
Summer Met Average	16 May–15 Aug	92	85	418	**4.9**	--
Summer Tree Average		184	154	10038	**65.2**	
Fall Met Average	16 Aug–3 Sep	19	19	235	**12.4**	--
Fall Tree Average		38	36	4609	**128.0**	
Survey Totals		954	788	18715	**23.8**	

*Seasons are not equal in length: spring = March 29 to May 15; summer = May 16 to August 15; fall = August 16 to September 3

** Detector-night is a sampling unit during which a single detector is deployed overnight. On nights when two detectors are deployed, the sampling effort equals two detector-nights, etc.

*** Number of ultrasound sequences recorded per detector-night.

**** Maximum number of ultrasound sequences recorded from any **single** detector for a 12-hour sampling period.

Table 2-2. Monthly summary of 2008 acoustic survey results at Buckeye Anabat detectors

Detector / Month	Dates	Number of Nights	Detector-nights*	Sequences Recorded	Detection Rate **	Max Recorded ***
North High						
March	29 Mar–31 Mar	3	3	0	0.0	0
April	01 Apr–30 Apr	30	7	0	0.0	0
May	01 May–31 May	31	31	35	1.1	7
June	01 Jun–30 Jun	30	30	59	2.0	6
July	01 Jul–31 Jul	31	24	49	2.0	5
August	01 Aug–31 Aug	31	31	111	3.6	14
September	01 Sep–03 Sep	3	3	18	6.0	10
North Low						
March	29 Mar–31 Mar	3	3	0	0.0	0
April	01 Apr–30 Apr	30	6	6	1.0	6
May	01 May–31 May	31	31	118	3.8	13
June	01 Jun–30 Jun	30	30	205	6.8	21
July	01 Jul–31 Jul	31	24	329	13.7	26
August	01 Aug–31 Aug	31	31	581	18.7	46
September	01 Sep–03 Sep	3	3	66	22.0	37
North Tree						
March	29 Mar–31 Mar	3	3	0	0.0	0
April	01 Apr–30 Apr	30	6	17	2.8	7
May	01 May–31 May	31	26	768	29.5	95
June	01 Jun–30 Jun	30	29	1980	68.3	398
July	01 Jul–31 Jul	31	23	2713	118.0	517
August	01 Aug–31 Aug	31	20	4733	236.7	688
September	01 Sep–03 Sep	3	3	1701	567.0	682
South High						
March	29 Mar–31 Mar	3	0	0	0.0	0
April	01 Apr–30 Apr	30	12	2	0.2	1
May	01 May–31 May	31	17	23	1.4	5
June	01 Jun–30 Jun	30	17	50	2.9	6
July	01 Jul–31 Jul	31	31	118	3.8	14
August	01 Aug–31 Aug	31	31	167	5.4	16
September	01 Sep–03 Sep	3	3	24	8.0	11
South Low						
March	29 Mar–31 Mar	3	3	0	0.0	0
April	01 Apr–30 Apr	30	30	63	2.1	9
May	01 May–31 May	31	31	84	2.7	9
June	01 Jun–30 Jun	30	30	109	3.6	7
July	01 Jul–31 Jul	31	31	163	5.3	18
August	01 Aug–31 Aug	31	31	401	12.9	33
September	01 Sep–03 Sep	3	3	30	10.0	11
South Tree						
March	29 Mar–31 Mar	3	2	0	0.0	0
April	01 Apr–30 Apr	30	30	354	11.8	106
May	01 May–31 May	31	31	2446	78.9	480
June	01 Jun–30 Jun	30	30	337	11.2	182
July	01 Jul–31 Jul	31	24	499	20.8	113
August	01 Aug–31 Aug	31	31	316	10.2	95
September	01 Sep–03 Sep	3	3	40	13.3	24
Overall Results		**954**	**788**	**18715**	**23.8**	--

* Detector-night is a sampling unit during which a single detector is deployed overnight. On nights when two detectors are deployed, the sampling effort equals two detector-nights, etc.

** Number of ultrasound sequences recorded per detector-night.

*** Maximum number of ultrasound sequences recorded from any **single** detector for a 12-hour sampling period.

2.3.2.1 Detection Rates per Guild Group and Species

The majority of the recorded call sequences for all detectors combined belonged to the BBSH guild (n = 11,238; 60.0%; Table 2-3). Calls identified as BBSH consisted primarily of calls that could not be identified as either species (n = 9148; 82%), followed by calls identified as big brown bats (n= 1948; 17%) and silver-haired bats (n = 106; 1%). The majority of call sequences at each individual detector was also identified as BBSH, except for the North and South High detectors, where LFUN calls were the most common (n= 112; 41% and n= 161; 42%, respectively; Table 2-3 and Figure 2-4 through Figure 2-7). Together, LFUN, HFUN, and unknown calls (the UNKN guild) comprised 32% (n=6009) of call sequences recorded at all detectors. When considered separately, the LFUN guild was the second most commonly identified guild across all detectors (n=3253; 17%), followed by the HFUN guild (n=2439; 13%; Table 2-3).

Calls identified as RBTB consisted primarily of call sequences identified as red bats (n = 496; 69%), followed by calls that could not be identified as either red bats or tri-colored bats (n = 213; 30%; Figure 2-7; Appendix A). Only 1% (n=9) of call sequences in the RBTB guild were identified as tri-colored bats. Only 3% of all calls were identified to the MYSP guild and 91% (n=546) of these call sequences were recorded at the North Tree detector. Call sequences identified as HB comprised only 1% of all calls sequences (n=148). The majority of HB calls (n=44; 30%) were recorded at the North Tree detector (Table 2-3). The detection rates of Lasurine species recorded at high and low positions within met towers showed peaks in silver-haired bat activity in early May and mid June, peaks in hoary bat activity in early June and mid July, and peaks in red bat activity in mid to late August (Figure 2-8).

Appendix A provides a series of tables with more specific information on the nightly timing, number, and species composition of recorded bat call sequences. Specifically, Appendix A Tables 1 through 6 provide information on the number of call sequences, by guild and suspected species, recorded at each detector and the weather conditions for that night. Stantec can provide a digital file of all acoustic calls, including all information about species identification and timing of calls from each detector on an hourly and nightly basis, should that information be desired.

Table 2-3. Distribution of detections by guild, March - September, 2008.

Detector	Guild							Total
	BBSH	HB	RBTB	MYSP	UNKN			
					HFUN	LFUN	Unknown	
North High	91	9	20	4	35	112	1	272
North Low	495	17	173	21	249	318	32	1,305
North Tree	7891	44	333	546	1586	1312	200	11,912
South High	120	29	25	4	44	161	1	384
South Low	343	24	70	4	102	304	3	850
South Tree	2298	25	96	24	423	1046	80	3,992
Total	**11238**	**148**	**717**	**603**	**2439**	**3253**	**317**	**18715**
Guild Composition %	**60%**	**1%**	**4%**	**3%**	**13%**	**17%**	**2%**	

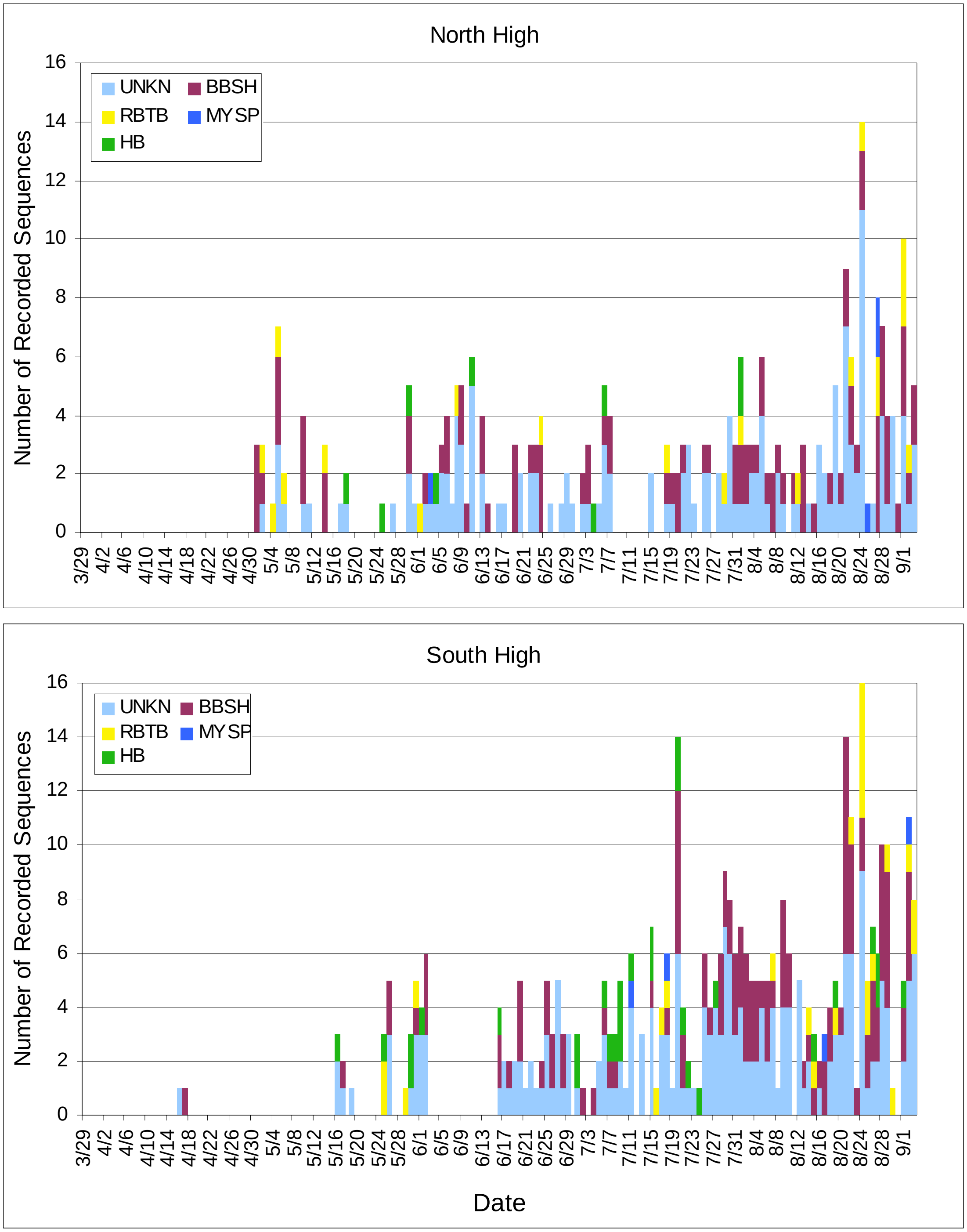


Figure 2-4. Nightly detections at the North and South High met detectors from March through September, 2008. *Guild codes: UNKN (unknown); RBTB (red bat/tri-colored bat); BBSH (big brown/silver haired); MYSP (*Myotis*); and HB (hoary bat).

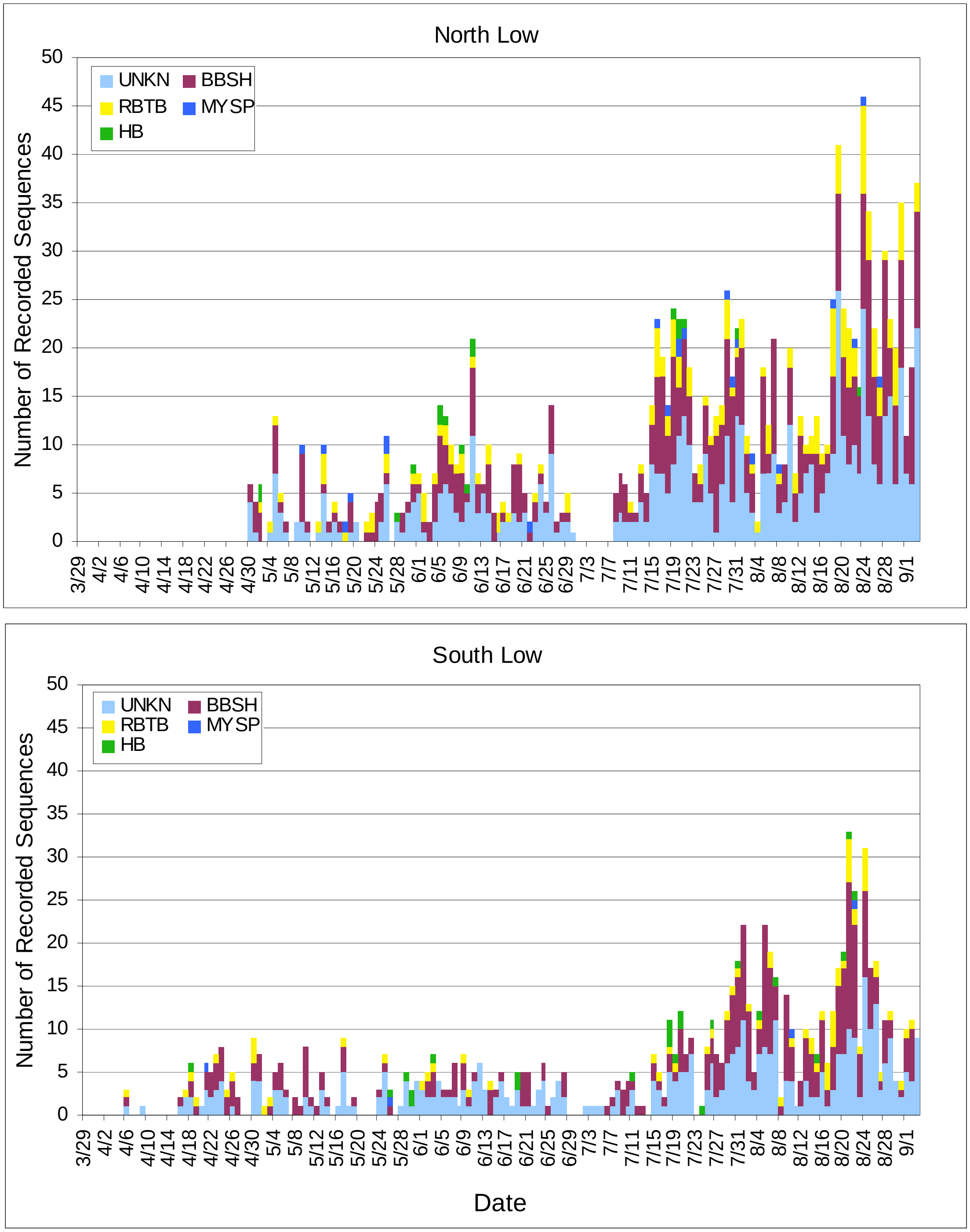
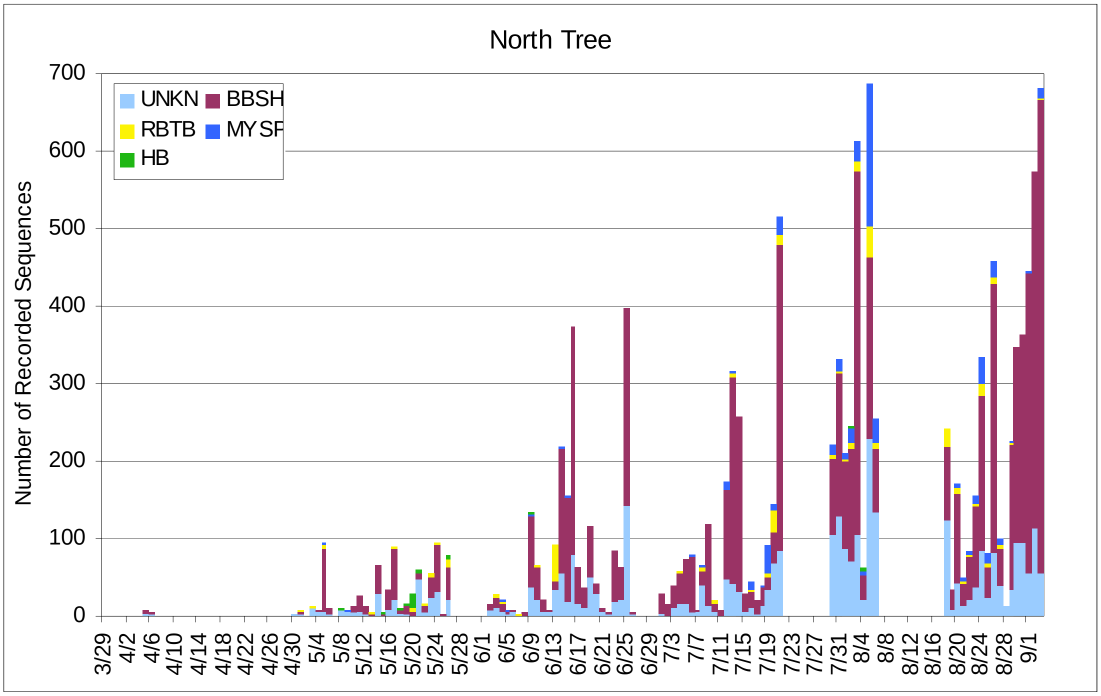


Figure 2-5. Nightly detections at the North and South Low met detectors from March through September, 2008. *Guild codes: UNKN (unknown); RBTB (red bat/tri-colored bat); BBSH (big brown/silver haired); MYSP (*Myotis*); and HB (hoary bat).



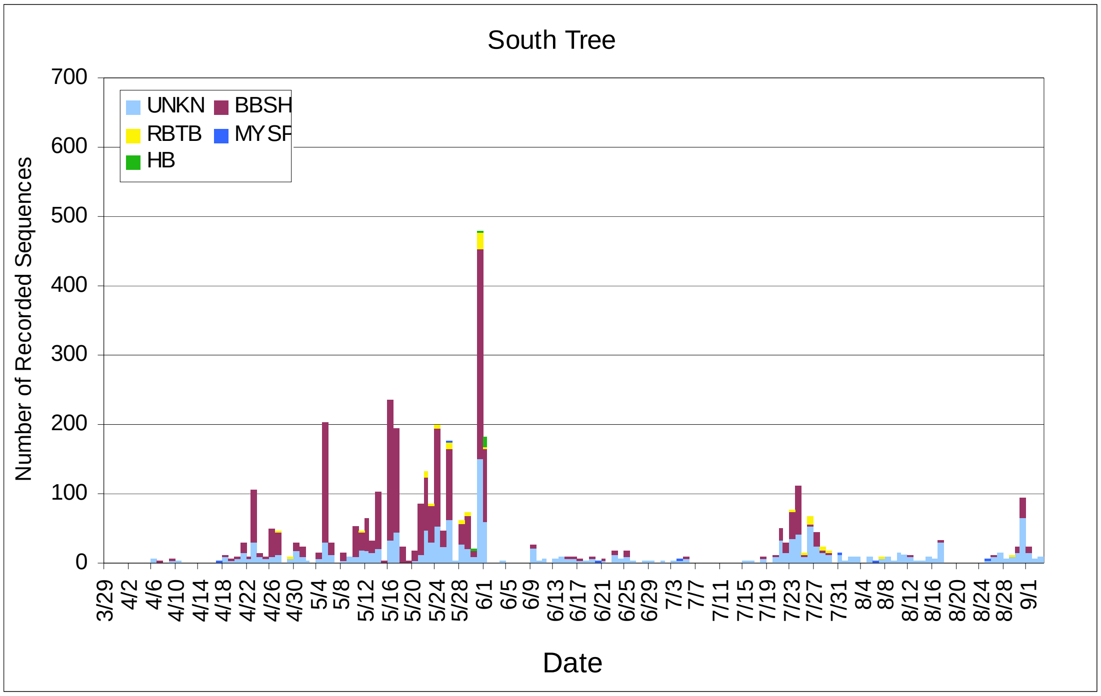


Figure 2-6. Nightly detections at the North and South Tree detectors from March through September, 2008. *Guild codes: UNKN (unknown); RBTB (red bat/tri-colored bat); BBSH (big brown/silver haired); MYSP (*Myotis*); and HB (hoary bat).

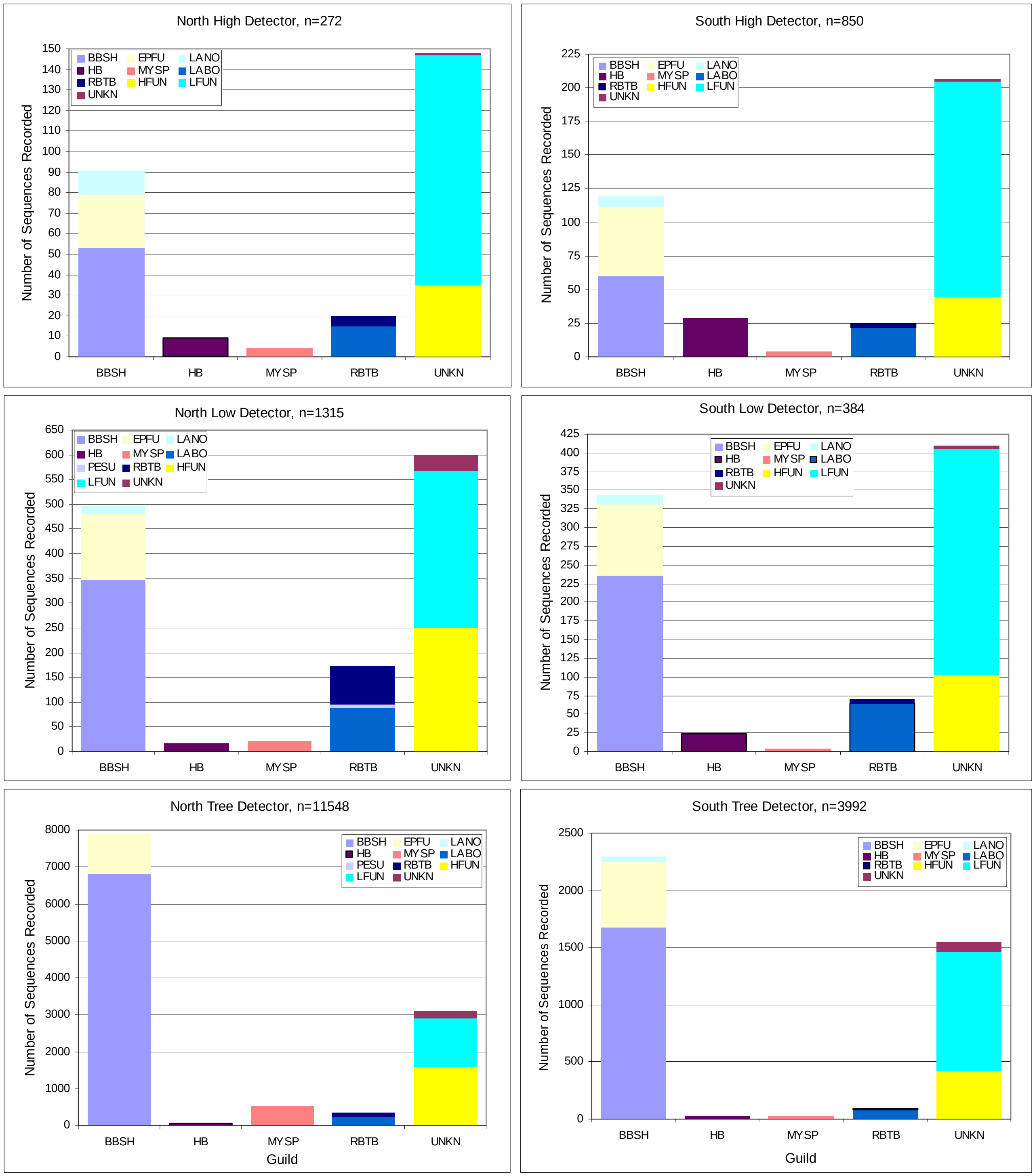


Figure 2-7. Summary of call sequences recorded during from March to September, 2008 by guild and species in the Project area. *Species codes: EPFU = big brown bat; LANO = silver-haired bat; PESU = tri-colored bat; LACI = hoary bat; LABO = red bat. *Guild codes: RBTB = red bat/ tri-colored bat; BBSH = big brown/ silver-haired bat; HB = hoary bat; MYSP = *Myotis*; UNKN = unknown; HFUN = high frequency unknown; LFUN = low frequency unknown.

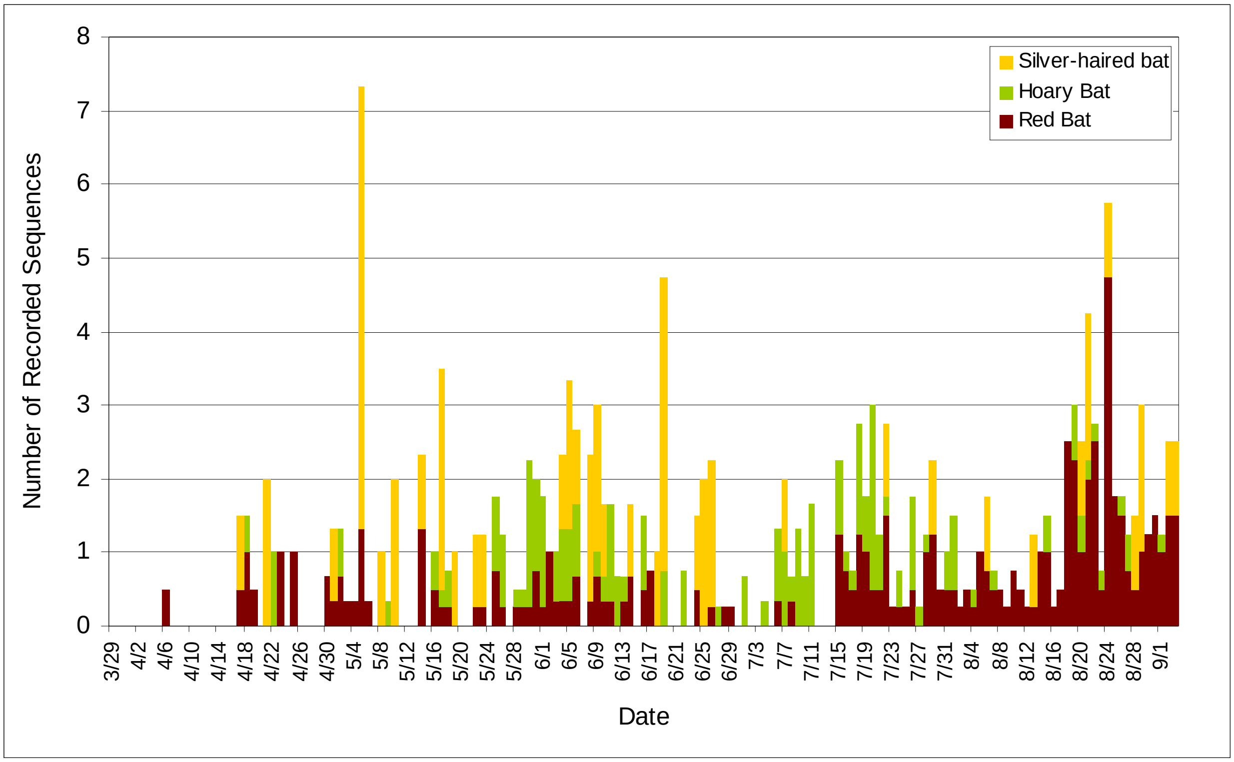


Figure 2-8. Nightly detections of Lasiurine species (silver-haired, red, and hoary bats) at met tower detectors from March through September, 2008.

2.3.2.2 Seasonal and Nightly Variation in Detection Rates

When comparing the total number of call sequences recorded in each month during the spring (March 29 through May 15), summer (May 16 through August 15), and fall (August 16 through September 3), all detectors, with the exception of the South Tree detector, showed similar trends in seasonal activity, whereby activity increased steadily throughout the sampling period and was the greatest in the fall (Figures 2-9 a and b). Detection rates at the South Tree detector dropped sharply in early June (Figure 2-9 b). This is not consistent with what would be expected, given typical bat activity associated with summer breeding and foraging activities. The sharp drop in detection rates after June 1 is difficult to explain. Although careful examination of field data sheets and detector status files did not indicate any problems, it is possible that some unknown malfunction (e.g., reduced microphone sensitivity as a result of water damage) was responsible for this unexpected trend, rather than a real biological phenomenon.

During the spring, call sequences recorded per night for all detectors combined ranged from a minimum of zero (nine nights) to 324 call sequences (May 5). During the summer, call sequences ranged from a minimum of 3 (June 30) to 749 call sequences (August 5). During the fall, call sequences ranged from a minimum of 32 (August 16) to 751 call sequences (September 3). Peaks in call volume varied with time of night, with the greatest activity occurring one and two hours after sunset (Figure 2-10).

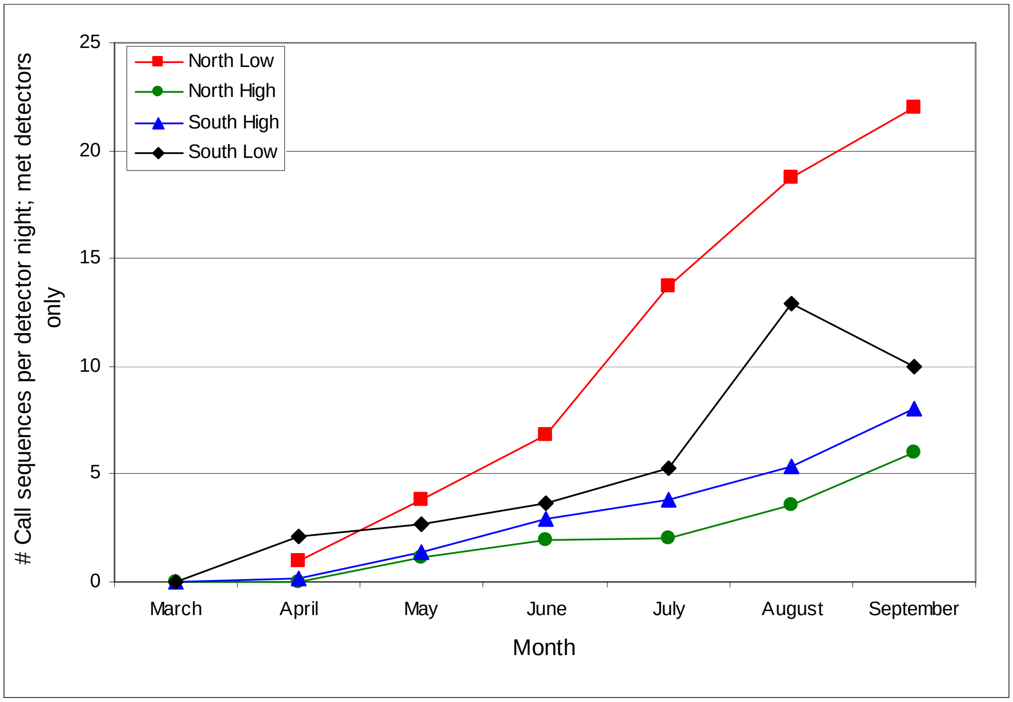


Figure 2-9a. Mean nightly detection rate summarized by month for all detectors suspended in met towers in the Project area from March through September 2008 (*note that March and September each included only three possible detector-nights).

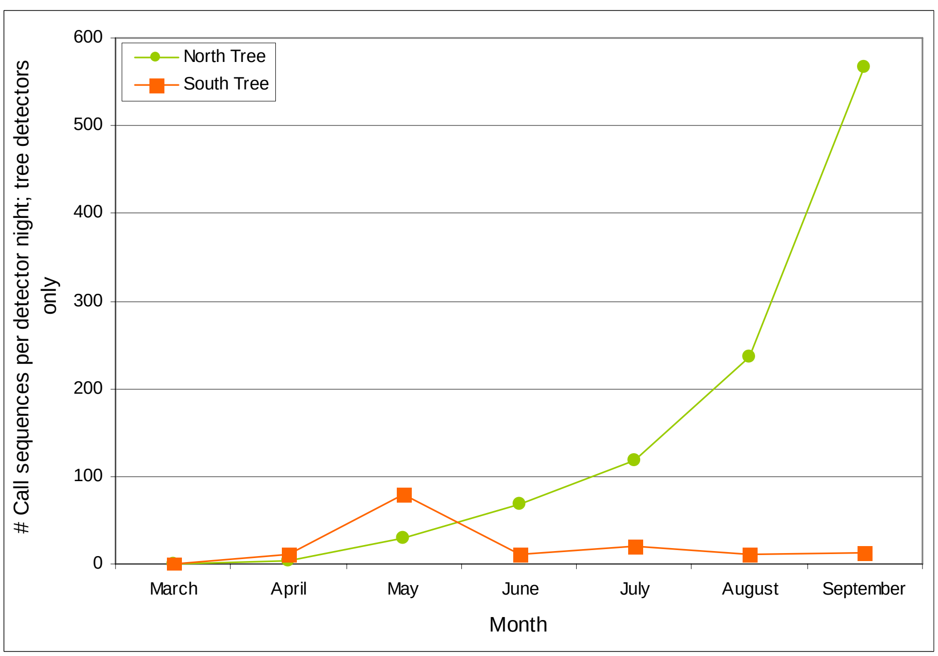


Figure 2-9b. Mean monthly detection rate for all tree detectors from March through September, 2008.
*Note that March and September each included only three possible detector-nights.

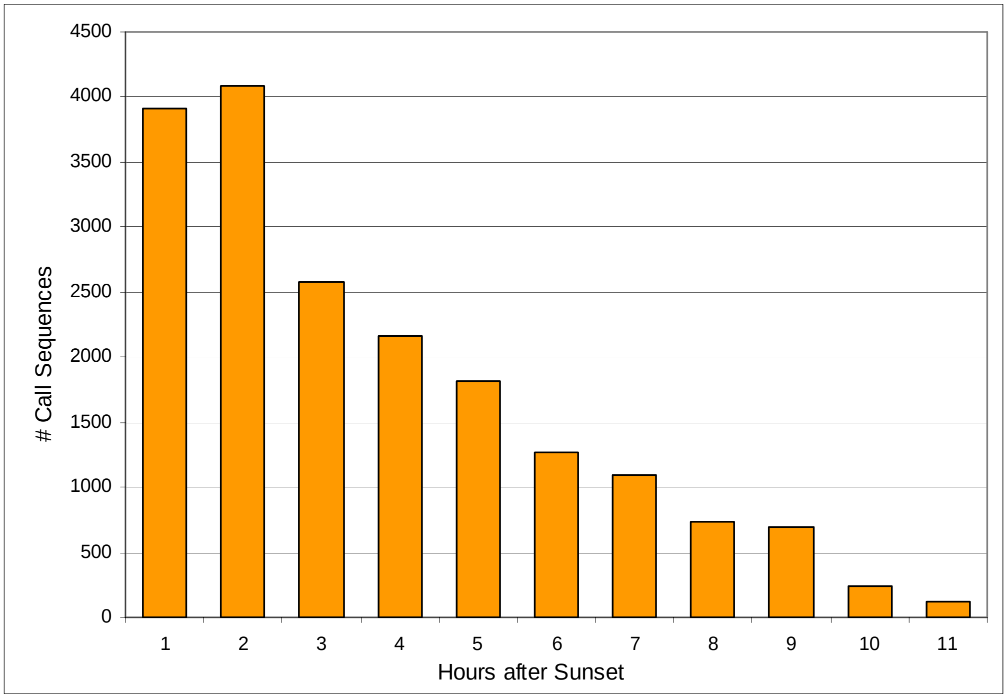


Figure 2-10. Distribution of hourly recorded call sequences at all detectors, March through September, 2008.

When the total number of call sequences recorded per night for all detectors combined is plotted against mean nightly temperatures, some patterns appear (Figure 2-11). Based on qualitative analysis, the number of recorded call sequences appears to remain relatively low at temperatures less than 10 ºC (50 ºF) and nights with peak activity were all recorded at temperatures greater than this. Similarly, when the total number of call sequences recorded per night for all detectors combined is plotted against mean nightly wind speeds, the number of call sequences recorded tended to be low at wind speeds greater than approximately 7.5 m/s (16.8 mph), although there were relatively few nights that had wind speeds greater than this (Figure 2-12).

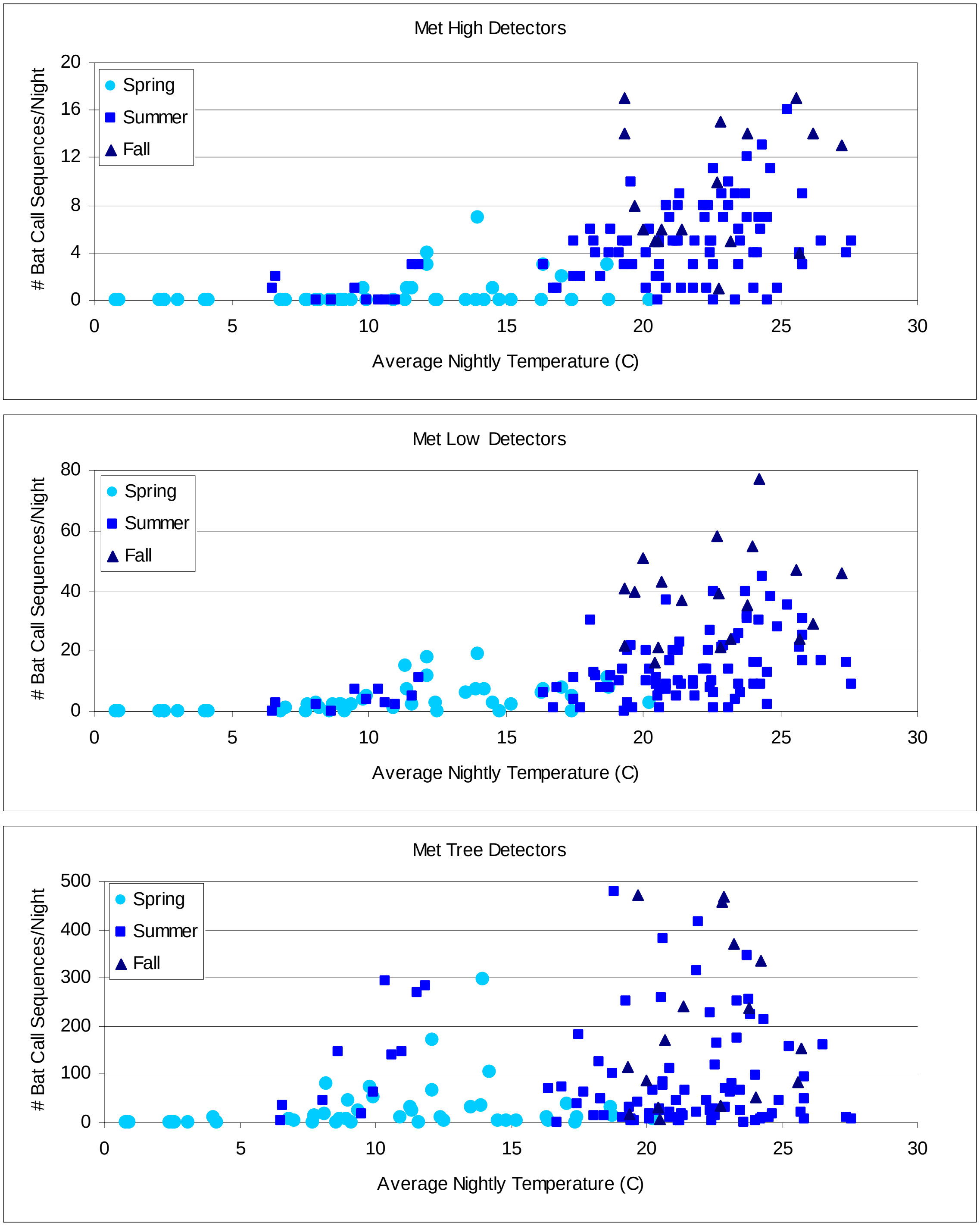


Figure 2-11. Total number of bat call sequences recorded each night at Met High, Low, and Tree detectors during spring, summer, and fall 2008, plotted against average nightly temperature (°C). *Note that weather data were not available from 3/29 through 3/31.

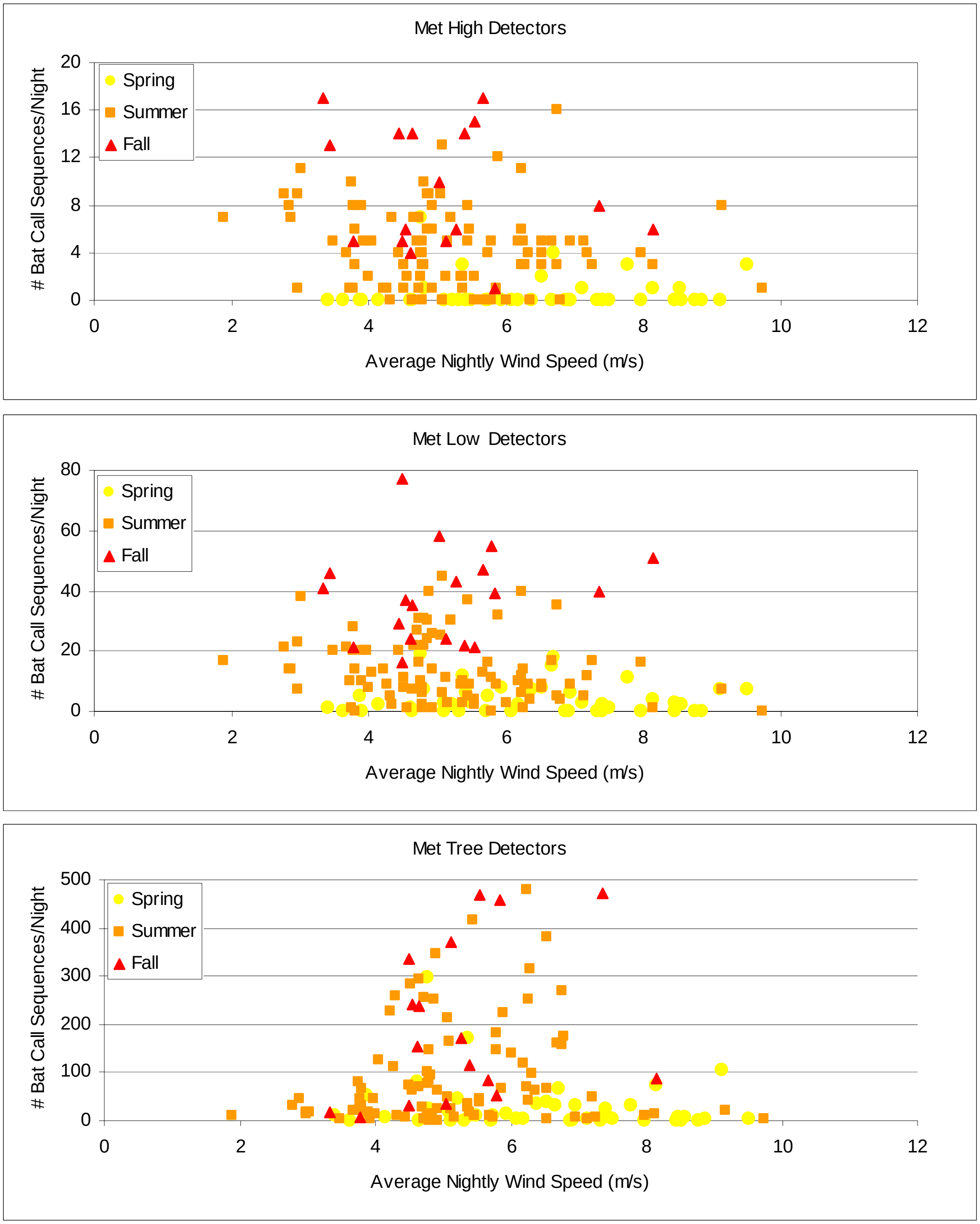


Figure 2-12. Total number of bat call sequences recorded each night at Met High, Low, and Tree detectors during spring, summer, and fall 2008, plotted against average nightly wind speed (m/s). *Note that weather data were not available from 3/29 through 3/31.

2.4 DISCUSSION AND CONCLUSIONS

Bat echolocation surveys provide insight into activity patterns, possible species composition, and timing of movements of bats in the Project area. In general, activity decreased with increasing detector height, with the highest activity recorded at ground-level detectors and the lowest activity recorded at the highest detectors suspended from the met towers. The highest overall numbers of call sequences per detector-night were recorded at the North Tree detector and the lowest numbers were recorded at the North High detector.

Differences in detection rates between guilds at the various detectors deployed in the Project area may reflect varying vertical distribution, habitat preferences, and unique foraging characteristics and behaviors of different bat species (Hayes 2000). The majority of *Myotis* call sequences were recorded at the tree detectors. This is not surprising since bats in the MYSP guild generally forage at lower altitudes and thus are more often picked up by ground-level detectors. Recent research using Anabat detectors recorded *Myotis* species more frequently at lower heights and larger species such as big brown and hoary bats were more frequently at higher heights (Arnett *et al*. 2006). While the *Myotis* calls in this survey followed this trend, the detection rates for big brown and hoary bats did not, as these species were most frequently recorded at tree detectors as well.

The interpretation of guild composition is confounded by the high number of UNKN call sequences. Unknown call sequences could not be identified to guild or species due to short call sequences (less than five pulses) or poor call signature formation, often a result of bats flying at the edge of the detection zone of the detector or flying away from the microphone. The relatively small area sampled by bat detectors makes scenarios leading to un-identifiable call sequences common, but some information can still be gleaned from these poor recordings. Specifically, 41% of UNKN sequences were identified as being HFUN, which likely consisted of red bats, tri-colored bats, and *Myotis* species, since these species nearly always produce ultrasound sequences greater than 30 kHz. Eighty-two percent of HFUN calls of were recorded at ground-level detectors. Because *Myotis* species are more frequently detected beneath the canopy level (Arnett *et al*. 2006), we suspect that the majority of HFUN sequences represent *Myotis* species. Thus, the *Myotis* species are likely more common in the Project area than the 3% detection rate of the MYSP guild suggests.

Recent studies have found that bat activity patterns are influenced by weather conditions (Arnett *et al*. 2006, Arnett *et al*. 2008, Reynolds 2006). Acoustic surveys have documented a decrease in bat activity rates as wind speed increase and temperatures decrease, and bat activity has been shown to correlate negatively to low nightly mean temperatures (Hayes 1997, Reynolds 2006). Similarly, weather factors appeared related to bat collision mortality rates documented at two facilities in the southeastern United States, with mortality rates negatively correlated with both wind speed and relative humidity, and positively correlated to barometric pressure (Arnett 2005). These patterns suggest that bats are more likely to be active on nights with low wind speeds (less than 4-6 m/s) and generally favorable weather (warm temperatures, low humidity, high barometric pressure). Thus, several weather variables individually affect bat activity, as does the interaction among variables (i.e., warm nights with low wind speeds, and high pressure).

A qualitative look at trends in weather conditions and detection rates (Figures 2-11 and 2-12) shows a potential relationship between temperature, wind speed, and bat activity rates. However, modeling these effects and interactions in a scientifically robust manner would require a substantially larger sample size and replication across the landscape. Sampling at the spatial and temporal scales used in this acoustic survey is not capable of showing interactions among conditions and the role of seasonal behaviors.

Additionally, nightly trends in mean detections and mean weather conditions mask small-scale variation that occurs within a night. There are many factors driving such small-scale variation in hourly number of recordings. Most North American bats species emerge from their roosts in large numbers shortly after dusk, periodically returning to their roosts for short periods during the night (see Hayes 1997 and cited references). This night-roosting behavior results in relatively higher activity levels shortly after dusk, when bats have not eaten or drank in many hours, and again just before dawn when many individuals will forage and drink again before returning to their roost for daylight hours. The observed hourly distribution of bat activity documented at acoustic detectors in the Project area is largely consistent with this literature, although a peak in activity before dawn was not observed.

Detection rates were generally higher at north met tower detectors than at the south met tower detectors. When comparing detection rates in the Project area to other wind project sites for which data are publicly available (Tables 2-4 and 2-5), average detection rates at the four met tower detectors (1.8 s/d/n in spring; 12.4 s/d/n in fall) were within the range of those observed at other sites in recent years. The average detection rates at the north and south tree detectors (17.7 s/d/n in spring; 128.0 s/d/n in fall) were relatively high when compared to other sites (although very few sites were available for comparison during the spring [n=4]).

Although the fall detection rate at the South Tree detector (13.1 s/d/n) was comparable to rates observed at other sites in the east, the rate at the North Tree detector (256.5 s/d/n) was very high. Calls at the North Tree detector were comprised mostly of call sequences identified to the BBSH guild (74%; n=3228). Fourteen percent of these calls were identified to species as big brown bat, and the majority of the remaining calls were likely also big brown bats, given that no silver-haired bats were captured during summer mist-netting surveys and big brown bats were the most frequently captured species, comprising 57% of all individuals captured (Stantec 2008). Given the exceptionally high number of call sequences recorded, it is likely that the North Tree detector was placed in close proximity to a big brown maternity colony and the detector was picking up local activity of bats foraging along the field edge where the detector was placed.

Only recently have acoustic surveys been conducted during the summer months and therefore, there are no publicly available surveys at other locations for comparison of rates documented during the breeding season.

Table 2-4. Summary of available spring bat detector surveys (results reported for individual detectors)

Year	Project	State	City	Habitat	Height (m)	Detector Nights	Start	End	Calls	Rate	Reference
Tree or low tower detectors (10 m or below)											
2006	Lempster	NH	Lempster	forest edge	5	21	4/5	6/12	16	0.8	Woodlot 2007a
2006	Howard	NY	Howard	field	8	35	4/15	6/3	29	0.8	Woodlot 2006f
2008	*Buckeye*	*OH*	*Urbana*	*field*	*2*	*24*	*3/29*	*5/15*	*300*	*12.5*	*this report*
2008	*Buckeye*	*OH*	*Urbana*	*field*	*2*	*47*	*3/29*	*5/15*	*957*	*20.4*	*this report*
2005	Sheffield	VT	Sheffield	forest edge	10	4	5/12	5/29	0	0	Woodlot 2006a
2006	Sheffield	VT	Sheffield	forest edge	8	38	4/24	6/13	840	22.1	Woodlot 2006a
2006	Sheffield	VT	Sheffield	forest edge	9	37	4/24	6/13	90	2.4	Woodlot 2006a
2006	Sheffield	VT	Sheffield	forest edge	8	34	4/24	6/13	178	5.2	Woodlot 2006a
2006	Deerfield	VT	Searsburg	forest edge	2	37	4/14	6/11	4	0.1	Woodlot 2005c
Met tower detectors											
2006	Kibby	ME	Eustis	forest edge	50	14	5/4	6/19	0	0	Woodlot 2006h
2006	Kibby	ME	Eustis	forest edge	50	24	5/4	6/19	0	0	Woodlot 2006h
2006	Kibby	ME	Eustis	forest edge	20	35	5/4	6/19	31	0.7	Woodlot 2006h
2006	Kibby	ME	Eustis	forest edge	50	35	5/4	6/19	0	0	Woodlot 2006h
2006	Lempster	NH	Lempster	forest edge	40	60	4/5	6/12	7	0.1	Woodlot 2007a
2006	Lempster	NH	Lempster	forest edge	20	50	4/5	6/12	3	0.1	Woodlot 2007a
2005	Cohocton	NY	Cohocton	field	30	29	5/2	5/30	21	0.7	Woodlot 2006c
2005	High Sheldon	NY	Sheldon	field	30	36	4/21	5/30	6	0.2	Woodlot 2006b
2005	Jordanville	NY	Jordanville	field	30	29	4/14	5/13	15	0.5	Woodlot 2005n
2005	Marble River	NY	Churubusco	field	30	46	4/14	5/30	12	0.3	Woodlot 2005l
2005	Prattsburgh	NY	Prattsburgh	field	30	17	4/15	5/10	8	0.5	Woodlot 2005b
2005	Prattsburgh	NY	Prattsburgh	field	15	20	4/11	5/30	8	0.4	Woodlot 2005b
2005	West Hill/Munnsville	NY	Munnsville	field	30	22	5/10	5/31	6	0.3	Woodlot 2005g
2006	Chateaugay	NY	Chateaugay	field	40	54	4/16	6/8	117	2.2	Woodlot 2006e
2006	Chateaugay	NY	Chateaugay	field	20	54	4/16	6/8	103	1.9	Woodlot 2006e
2006	Howard	NY	Howard	field	50	36	4/15	6/4	5	0.1	Woodlot 2005o
2006	Howard	NY	Howard	field	20	45	4/15	6/7	16	0.4	Woodlot 2005o
2005	Clayton	NY	Clayton	forest edge	20	42	4/20	5/31	55	1.3	Woodlot 2005m
2005	Clayton	NY	Clayton	forest edge	15	36	4/20	5/31	12	0.3	Woodlot 2005m
2005	Stamford/Moresville	NY	Stamford	forest edge	30	27	4/12	5/8	8	0.3	Woodlot 2005e
2008	*Buckeye*	*OH*	*Urbana*	*field*	*40*	*25*	*3/29*	*5/15*	*24*	*1.0*	*this report*
2008	*Buckeye*	*OH*	*Urbana*	*field*	*20*	*24*	*3/29*	*5/15*	*66*	*2.8*	*this report*
2008	*Buckeye*	*OH*	*Urbana*	*field*	*40*	*13*	*3/29*	*5/15*	*2*	*0.2*	*this report*
2008	*Buckeye*	*OH*	*Urbana*	*field*	*20*	*48*	*3/29*	*5/15*	*108*	*2.3*	*this report*
2005	Deerfield	VT	Searsburg	forest edge	15	40	4/19	6/15	4	0.1	Woodlot 2005j
2005	Sheffield	VT	Sheffield	forest edge	20	31	5/1	5/31	6	0.2	Woodlot 2006a
2006	Deerfield	VT	Searsburg	forest edge	35	60	4/14	6/13	4	0.1	Woodlot 2005s
2006	Deerfield	VT	Searsburg	forest edge	15	47	4/14	5/31	0	0	Woodlot 2005s
2006	Deerfield	VT	Searsburg	forest edge	30	29	4/14	5/20	0	0	Woodlot 2005s
2006	Deerfield	VT	Searsburg	forest edge	15	21	4/14	5/16	7	0.3	Woodlot 2005s
2006	Sheffield	VT	Sheffield	forest edge	31	36	4/24	6/13	5	0.14	Woodlot 2005a
2005	Liberty Gap	WV	Harper	forest edge	30	21	4/17	6/7	2	0.1	Woodlot 2005k
2005	Liberty Gap	WV	Harper	forest edge	15	21	4/17	6/7	19	0.9	Woodlot 2005k

Table 2-5. Summary of available fall bat detector surveys (results reported for individual detectors)

Year	Project	State	City	Habitat	Height (m)	Detector Nights	Start	End	Calls	Rate	Reference
Tree or Low Tower detectors (10 m or below)											
2005	Lempster	NH	Lempster	forest edge	7.5	34	9/20	10/31	27	0.8	Woodlot 2005d
2005	Lempster	NH	Lempster	forest edge	2	42	9/20	10/31	2	0	Woodlot 2005d
2006	Lempster	NH	Lempster	forest edge	10	29	9/9	10/24	2	0.1	Woodlot 2007a
2006	Lempster	NH	Lempster	forest edge	3	44	9/9	10/24	384	8.7	Woodlot 2007a
2005	High Sheldon	NY	Sheldon	field	2	49	8/1	10/4	5535	113	Woodlot 2005n
2005	Howard	NY	Howard	field	2	25	8/3	8/27	1493	51.5	Woodlot 2005o
2005	Jordanville	NY	Jordanville	field	2	34	8/12	9/22	124	4.4	Woodlot 2005q
2005	Marble River/Churubusco	NY	Churubusco	field	10	34	8/1	10/11	150	4.4	Woodlot 2005l
2005	Marble River/Churubusco	NY	Churubusco	field	2	18	8/1	10/11	113	6.3	Woodlot 2005l
2005	Top Notch	NY	Fairfield	field	2	34	8/19	9/21	44	1.3	Woodlot 2005p
2005	West Hill	NY	Munnsville	field	2	30	8/1	10/21	10	0.3	Woodlot 2005r
2005	Clayton	NY	Clayton	forest edge	2	33	8/19	9/20	154	4.7	Woodlot 2005m
2005	Stamford/Moresville	NY	Stamford	forest edge	2	58	8/15	10/15	280	4.8	Woodlot 2005e
2008	*Buckeye*	*OH*	*Urbana*	*field*	*2*	*17*	*8/15*	*9/3*	*4361*	*256.5*	*this report*
2008	*Buckeye*	*OH*	*Urbana*	*field*	*2*	*19*	*8/15*	*9/3*	*248*	*13.1*	*this report*
MET Tower Detectors											
2005	Dans Mountain	MD	Loarville	forest edge	11	53	8/1	9/22	574	10.8	Woodlot 2005a
2005	Dans Mountain	MD	Loarville	forest edge	23	31	8/1	9/22	388	12.5	Woodlot 2005a
2006	Kibby	ME	Eustis	forest edge	45	72	6/20	10/25	18	0.3	Woodlot 2006m
2006	Kibby	ME	Eustis	forest edge	45	76	6/20	10/25	0	0	Woodlot 2006m
2006	Kibby	ME	Eustis	forest edge	20	44	6/20	10/25	4	0.1	Woodlot 2006m
2006	Kibby	ME	Eustis	forest edge	45	20	6/20	10/25	0	0	Woodlot 2006m
2006	Redington	ME	Redington	forest edge	15	21	8/10	10/24	0	0	Woodlot 2005u
2006	Redington	ME	Redington	forest edge	15	48	8/10	10/24	0	0	Woodlot 2005u
2006	Redington	ME	Redington	forest edge	30	29	8/10	10/24	0	0	Woodlot 2005u
2006	Redington	ME	Redington	forest edge	30	37	8/10	10/24	0	0	Woodlot 2005u
2006	Stetson	ME	Danforth	forest edge	30	73	6/28	10/16	8	0.1	Woodlot 2007b
2006	Stetson	ME	Danforth	forest edge	30	76	6/28	10/16	170	2.2	Woodlot 2007b
2006	Stetson	ME	Danforth	forest edge	15	105	6/28	10/16	108	1	Woodlot 2007b
2006	Stetson	ME	Danforth	forest edge	15	107	6/28	10/16	651	6.1	Woodlot 2007b
2005	Lempster	NH	Lempster	forest edge	15	42	9/20	10/31	14	0.3	Woodlot 2005d
2006	Lempster	NH	Lempster	forest edge	40	43	9/9	10/24	16	0.4	Woodlot 2007a
2005	High Sheldon	NY	Sheldon	field	15	65	8/1	10/4	335	5.2	Woodlot 2005n
2005	High Sheldon	NY	Sheldon	field	30	58	8/1	10/4	137	2.4	Woodlot 2005n
2005	Howard	NY	Howard	field	30	13	8/3	8/19	30	2.3	Woodlot 2005o
2005	Howard	NY	Howard	field	27	15	8/3	8/14	30	2	Woodlot 2005o
2005	Jordanville	NY	Jordanville	field	15	34	8/12	9/22	143	4.2	Woodlot 2005q
2005	Jordanville	NY	Jordanville	field	30	41	8/12	9/22	255	6.2	Woodlot 2005q
2005	Marble River/Churubusco	NY	Churubusco	field	20	39	8/1	10/11	243	6.2	Woodlot 2005l
2005	Top Notch	NY	Fairfield	field	15	34	8/19	9/21	30	0.9	Woodlot 2005p
2005	Top Notch	NY	Fairfield	field	30	34	8/19	9/21	99	3	Woodlot 2005p
2005	West Hill	NY	Munnsville	field	15	47	8/1	10/21	179	3.8	Woodlot 2005r
2005	West Hill	NY	Munnsville	field	30	52	8/1	10/21	106	2	Woodlot 2005r
2006	Steuben	NY	Hartsville	field	15	76	7/26	10/10	119	1.6	EDR 2006b
2006	Steuben	NY	Hartsville	field	30	49	7/26	10/10	84	1.7	EDR 2006b
2006	Wethersfield	NY	Wethersfield	field	15	54	7/25	10/9	0	0	Woodlot 2006l
2006	Wethersfield	NY	Wethersfield	field	30	26	7/25	10/9	22	0.8	Woodlot 2006l
2006	Centerville	NY	Centerville	field	15	48	7/25	10/10	2	0	Woodlot 2006l
2006	Centerville	NY	Centerville	field	35	41	7/25	10/10	3	0.1	Woodlot 2006l
2006	Chateaugay	NY	Chateaugay	field	40	58	7/25	10/4	173	3	Woodlot 2006j
2006	Chateaugay	NY	Chateaugay	field	20	44	7/25	10/4	345	7.8	Woodlot 2006j
2006	Dutch Hill	NY	Cohocton	field	15	43	8/12	10/11	46	1.1	Woodlot 2006c
2006	Dutch Hill	NY	Cohocton	field	30	47	8/12	10/11	57	1.2	Woodlot 2006c
2005	Clayton	NY	Clayton	forest edge	30	0	8/19	9/20	0	0	Woodlot 2005m
2005	Stamford/Moresville	NY	Stamford	forest edge	15	43	8/15	10/15	293	6.8	Woodlot 2005e
2005	Stamford/Moresville	NY	Stamford	forest edge	30	54	8/15	10/15	285	5.3	Woodlot 2005e
2008	*Buckeye*	*OH*	*Urbana*	*field*	*40*	*19*	*8/15*	*9/3*	*90*	*4.7*	*this report*
2008	*Buckeye*	*OH*	*Urbana*	*field*	*20*	*19*	*8/15*	*9/3*	*461*	*24.3*	*this report*
2008	*Buckeye*	*OH*	*Urbana*	*field*	*40*	*19*	*8/15*	*9/3*	*123*	*6.5*	*this report*
2008	*Buckeye*	*OH*	*Urbana*	*field*	*20*	*19*	*8/15*	*9/3*	*265*	*13.9*	*this report*

The detection rates at individual detectors during fall 2008 were different than those recorded at the same locations during fall 2007 from August 28 to October 29, 2007 (Stantec 2007). For example, the South Tree detector had the highest call rate (28.4 s/d/n) in fall 2007, while the North Tree detector had the lowest call rate (3.5 s/d/n) of all six detectors in fall 2007. However, the North Tree detector suffered from a large number of malfunctions during fall 2007 and only operated on 25 of the 63 potential detector nights (40% success rate), making it difficult to interpret and compare results. Differences in survey results between years is somewhat expected, given that the survey periods only overlapped slightly and each survey likely captured different biological phenomena, such as migration peaks of different species. Additionally, it is expected that year to year variation in local bat populations and weather conditions will also affect acoustic survey results.

Thus, caution should be used when comparing the levels of activity among different years, or to rates detected in other acoustic surveys. Numbers of recorded bat call sequences are not necessarily correlated with numbers of bats in an area because acoustic detectors do not allow for differentiation between a single bat making multiple passes, and multiple bats each recorded individually (Hayes 2000). Additionally, differences in methodology, sampling duration, habitat, detector placement, and physiographic conditions among surveys limit our ability to make meaningful comparisons. Further limiting our interpretation of acoustic survey results, in terms of predicting risk to bats, is the fact that no studies to date have linked pre-construction acoustic activity rates with post-construction fatality rates.

Despite these limitations, the discussed patterns in peak timing of detection rates, and patterns of species at different detector heights may be useful for predicting peak timing of potential bat fatalities and the species that are most at risk during those times. Recent studies of mortalities at wind developments have found bat mortality rates are highest among the Lasiurines (red, silver-haired, and hoary bats) known to be long-distance migrants (Cryan 2003, Kunz *et al*.2007a, Arnett *et al*. 2008). This pattern in mortality has led some to suggest that it is related to the species' migratory behavior (Cryan and Brown 2007). Peak mortality rates beginning around August 1 is typical among post-construction studies from the eastern United States (Arnett *et al*. 2008, Kunz *et al*. 2007a).

Trends in bat activity suggest that there is migratory activity occurring in the Project area. This is evidenced by a peak in total bat detections at almost all detectors during the period from mid August to early September. However, when looking at detections of Lasiurine species at high and low detectors in met towers from mid August to early September, only red bats displayed an obvious peak in activity. Conversely, hoary and silver-haired bats did not display peak activity during this time, but rather had high detection rates earlier in the survey, during the spring migratory or summer breeding season. Because red bats were the only Lasiurine species to show a peak in activity at met tower detectors during the early fall migratory period when bat fatalities have been found to be most numerous, it is possible that bat mortalities at the Project could be greatest in mid to late August and early September, and that these mortalities could consist mostly of red bats.

However, it is important to note that sampling was not continued beyond September 3, 2008 because an acoustic survey in the Project area was conducted from September 1 through October 15, 2007, as per the approved ODNR work plan (Stantec 2007). Therefore, it is possible that silver-haired bats and hoary bats experienced peaks later in the fall that were not captured in the 2008 survey. Results from the fall 2007 survey showed minimal hoary bat activity overall, with no conspicuous peaks in activity during the fall (Stantec 2007). However, there was a peak in silver-haired detections in early October, 2007, which could indicate increased risk for this species later in the fall. On the other hand, it is very important to acknowledge that precise estimates of mortality are not possible, and number of bat call sequence recordings per night may not be as useful in predicting mortality as are the results of post-construction surveys at nearby wind developments.

3.0 Diurnal Raptor and Sandhill Crane Survey

3.1 INTRODUCTION

The Project area is located in the Central Continental Hawk Flyway. Geography and topography are major factors in shaping migration dynamics in this flyway. The orientation of the Great Lakes and inland mountain ranges influence diurnal migrants in central Canada and the mid-west to fly generally southwestward to their wintering grounds in fall and northeastward in the spring, with considerable east to west movement along the Great Lake shorelines (Kerlinger 1989, Kellogg 2004). The juxtaposition of the Appalachian Mountain ranges and large bodies of water influence the distribution of raptor migration. Away from features such as the Lake Erie shore, the Alleghany and Appalachian plateaus may provide "leading lines" for hawks to follow (Kellogg 2004). Away from “leading lines” and shores, raptors may utilize low relief upland areas; however, migration is not expected to concentrate in landscapes suboptimal for migration, such as the interior of the mid-west. There are twenty species of raptors typically observed in this flyway.

In order to minimize energy expenditure, raptors typically use ridgelines or shorelines to gain altitude via thermal development or ridge-generated updrafts (Kerlinger 1989). Areas of northern Ohio, on and near Lake Erie, support concentrations of migrant raptors which typically avoid lengthy water crossings. The topography surrounding the Project does not contain any outstanding features that typically concentrate raptors by providing reliable updrafts, such as high relief ridges and plateaus. Raptor migration through central Ohio is likely less concentrated than in other areas of the Central flyway because ridges and lake shores are not prevalent.

The Project is located in the south-central portion of the state in the Bellefontaine Uplands physiographic region, a sub-region of the Central Ohio Till Plains. This region is characterized by low to moderate relief (76 m; 250 ft) hills formed by glacial processes during the last glacial maximum. Well to the east of the Project area, the Alleghany Plateaus rise to slightly higher elevations with much greater relief. It is suspected that the majority of raptor migration, away from the Lake Erie shoreline, would occur along the escarpments and leading lines of the

Alleghany Plateau area. It is therefore likely that raptors migrating through central Ohio exhibit broad front migratory behavior, in which the migrants move across the landscape with little or no deviation due to topographic features.

Stantec conducted raptor surveys on 11 days in 2007 during August, September, and October to determine if significant raptor migration occurs in the vicinity of the proposed. The ODNR subsequently requested that Stantec perform additional surveys in spring and fall 2008 to provide additional information on raptor activity in the Project area. In addition to this, the ODNR requested that sandhill crane surveys (*Grus canadensis*) be conducted, following the same protocol as the raptor surveys, during late winter 2008 to document their use of the Project area. The goal of both surveys was to document the occurrence of diurnally migrating birds in the vicinity of the Project area, including the number and species, approximate flight altitude, general direction and flight path, as well as other notable flight behavior.

3.2 METHODS

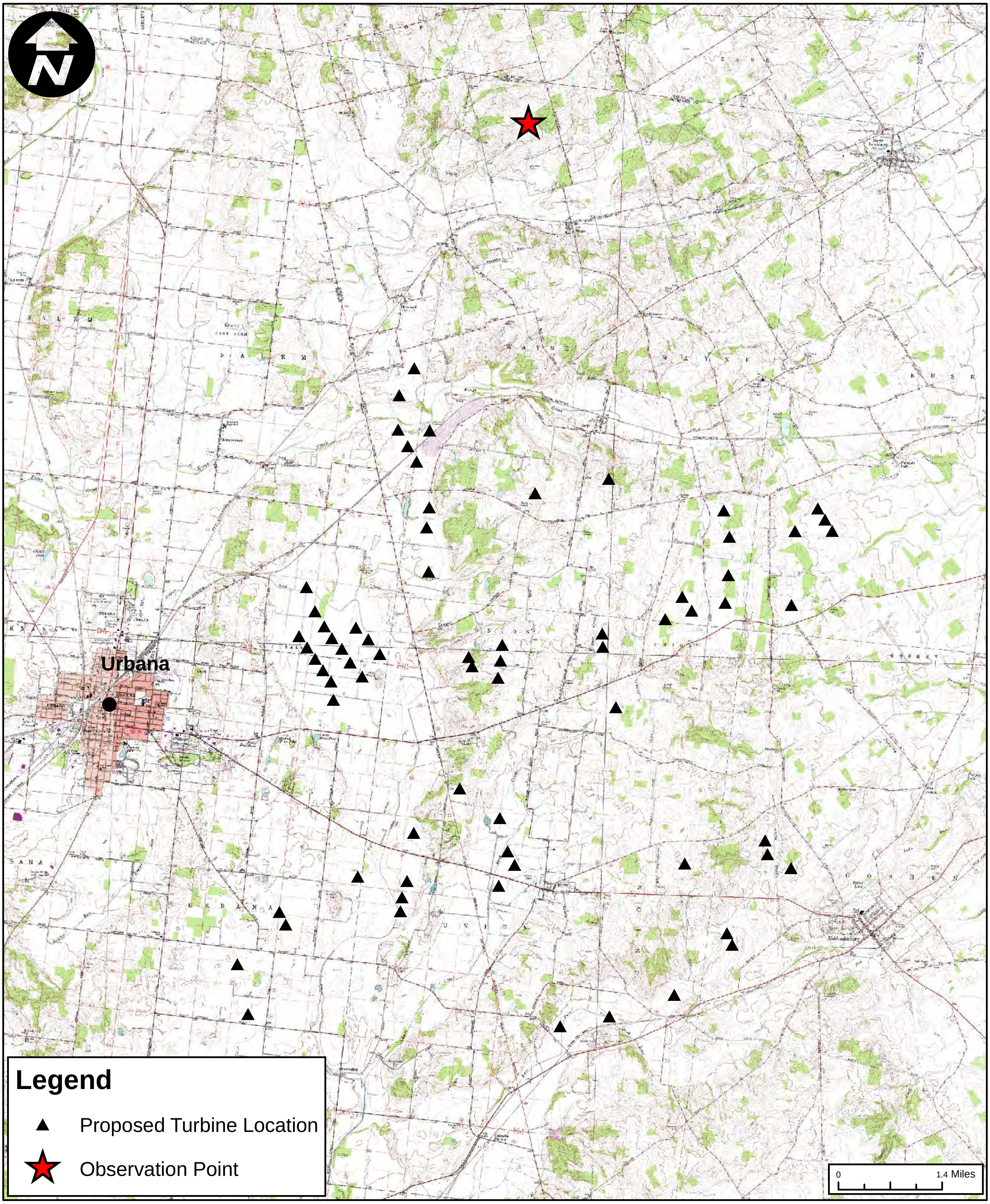
3.2.1 Field Surveys

Surveys were conducted from a hill top clearing northwest of Mingo, Ohio at an elevation of approximately 442 m (1,450 ft) (Figure 3-1). The observation site was in open and active pastureland in the central region of the Project area that offered excellent views to the south, east, and west, and good views to the north. The observation site was near a 100 m (328 ft) communication tower that provided a reference point for judging bird flight altitudes.

Raptor surveys were targeted to occur at least three days per week from March 1 to May 15, 2008 and from September 1 to November 15, 2008. Sandhill crane surveys were targeted to occur at least three days per week from November 16 to December 15, 2008. Surveys were conducted from 9:00 am to 5:00 pm in order to include the time of day when the strongest thermal updrafts are typically produced and when the majority of raptor migration activity generally occurs. Days with favorable flight conditions, produced by high-pressure systems and the passage of weather fronts were targeted.

Surveys were based on methods developed by the Hawk Migration Association of North America (HMANA 2007). Observers scanned the sky and surrounding landscape for raptors flying through the area. Observations were recorded onto HMANA data sheets, which summarize data by hour. Detailed notes on each observation, including location and flight path, flight altitude, and activity of the bird were recorded.

Flight altitudes were categorized as less than or greater than 150 m (492 ft) above ground, the proposed maximum height of the proposed wind turbines with blades oriented straight up. Nearby objects with known altitudes, such as a communication tower and surrounding trees, were used to gauge flight altitudes. Information regarding the bird’s behavior, and whether a bird was observed in the same locations throughout the survey period, was used to differentiate between migrant and resident raptors. The general flight paths of observed individuals were plotted on topographic maps of the Project area.



Prepared By:

Stantec

Sheet Title:

Raptor and Sandhill Crane Survey Location Map

Project:

Buckeye Wind Power Project, Ohio

Date: February 2009

Scale: 1" = 1.8 Miles

Proj. No.: 195600164

Figure:

3-1

Hourly weather observations, including wind speed, wind direction, temperature, percent cloud cover, and precipitation were also recorded on HMANA data sheets. Birds that flew too rapidly or were too far to accurately identify were recorded as unidentified to their genus or, if the identification of genus was not possible, unidentified raptor.

3.2.2 Data Analysis

Field observations were summarized by species for each survey day and for the entire survey period. This included a tally of the total number of individuals observed for each species, the observation rate (birds/hour), and an estimate of how many observations were suspected residents. The total number of birds, by species and by hour, was also calculated, as was the species composition of birds observed flying below and above 150 m (492 ft). Finally, the mapped flight locations of individuals were reviewed to identify any overall patterns for migrating raptors.

Raptor observations from the Project area were compared to the closest HMANA hawk watch sites for which data were available (HMANA 2007; Appendix B, Table 4). Comparisons were also made to 14 spring and 17 fall diurnal raptor surveys conducted from 1996 to 2006 that were publicly available for other wind projects through the northeast (Appendix B, Table 5).

3.3 RESULTS

Raptor surveys occurred on 32 days (216 hours) from March 1 to May 15, 2008, and on 24 days (167 hours) from September 1 to November 15, 2008. Sandhill crane surveys occurred on 12 days (84 hours) from November 16 to December 15, 2008. A total of 1,476 raptors representing twelve species were observed in the spring, yielding an observation rate of 6.8 birds/hour (Figures 3-2a and 3-2b; Appendix B, Table 1a). A total of 581 raptors representing seven species were observed during the fall raptor survey, yielding an observation rate of 3.5 birds/hour (Figures 3-2a and 3-2b; Appendix B, Table 1b).

Although no sandhill cranes were observed from November 15 to December 15, four sandhill cranes were observed during a raptor survey on March 6, 2008. During the sandhill crane survey, 27 raptors representing six species were observed, yielding an observation rate of 0.3 birds/hour during this period (Appendix B, Table 1c). Throughout the spring and fall, daily count totals ranged from 1 to 94 observed raptors and passage rates ranged from 0.1 to 14.3 birds/hour. The high count of 94 raptors occurred on May 6 when winds were moderate (3.4 – 7.5 km/hr) and predominantly from the southwest.

Surveys were conducted on mostly clear to partly cloudy days with no or minimal precipitation, allowing for optimal visibility. The development of thermals on survey days was evident as temperatures increased and cumulus clouds developed. Winds were variable throughout the survey period, wind speed was generally moderate to high (0 – 8 m/s; 18 mph), and temperatures ranged from -5 ºC (23 ºF) to 32 ºC (90 ºF).

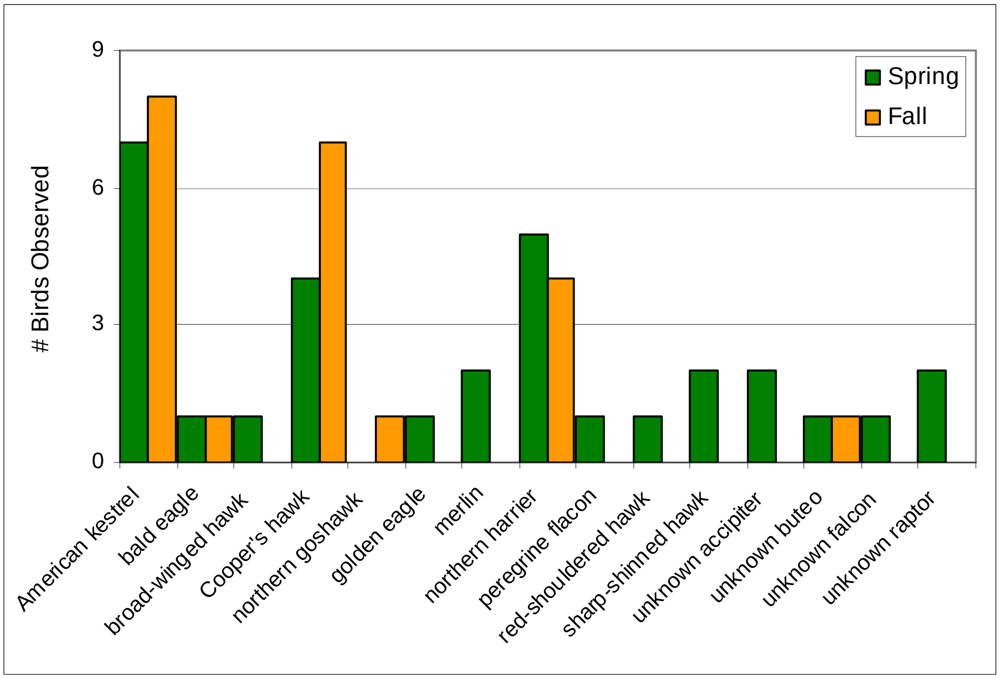


Figure 3-2a. Species composition of low-occurrence raptor species observed during spring (March 1 through May 15) and fall (September 1 through November 15) 2008 raptor surveys.

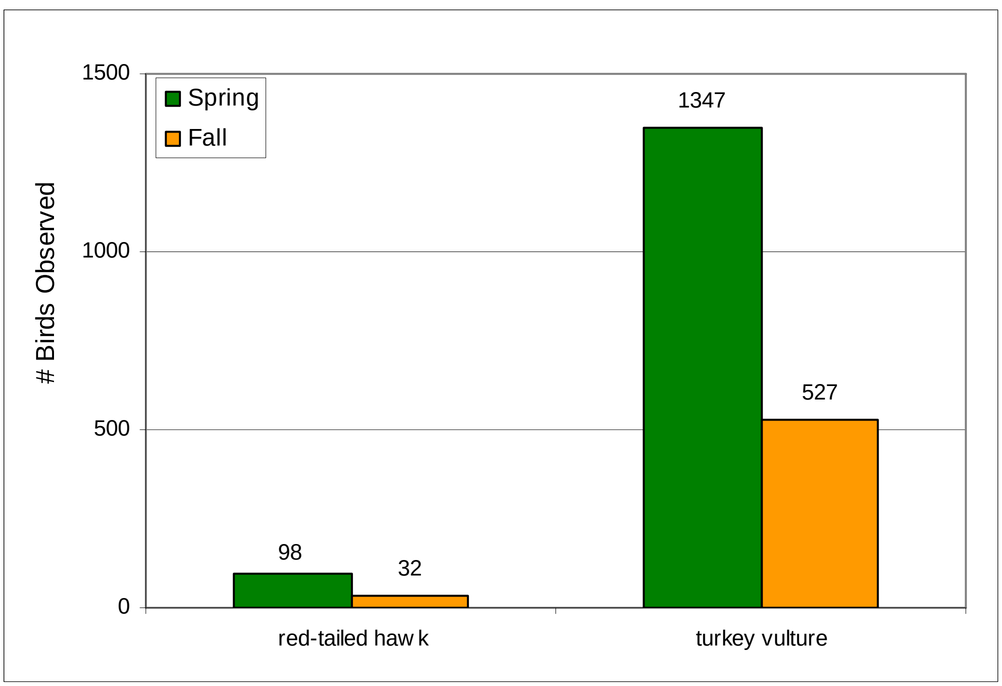


Figure 3-2b. Species composition of high-occurrence raptor species observed during spring (March 1 through May 15) and fall (September 1 through November 15) 2008 raptor surveys.

Turkey vulture (*Cathartes aura)*[2] was by far the most abundant species observed in the area during both the spring and fall survey period (spring n=1,347, 91%; fall n=527, 91%). Red-tailed hawks (*Buteo jamaicensis*) were the second most commonly observed species accounting for 7% of the total observations (n=98) in the spring, and 6% (n=32) in the fall. A number of unidentified raptors were observed that were too far from the observer to accurately determine genus. Other species observed in low numbers in the spring or fall included three species of accipiter [Cooper's hawk (*Accipiter cooperii*), sharp-shinned hawk (*Accipiter striatus*), and northern goshawk (*Accipiter gentilis*)]; two species of buteo [broad-winged hawk (*Buteo platypterus*) and red-shouldered hawk (*Buteo lineatus*)];three species of falcon [merlin (*Falco columbarius*), peregrine falcon (*Falco peregrinus*), and American kestrel (*Falco sparverius*)]; two species of eagle [bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*)]; and northern harriers (*Circus cyaneus*). Of the species observed during the survey, the northern harrier is state-listed as endangered, the peregrine falcon and bald eagle are state-listed as threatened, and the sharp-shinned hawk is a state species of concern in Ohio (ODNR 2007).

Eight percent of observed raptors were believed to be residents of the Project area because they were seen repeatedly foraging and perching at consistently similar locations throughout the survey period. In these cases, a particular individual may have been repeatedly observed flying back and forth across a section of hillside or perching in an area during the same day or on more than one survey day. However, for the most part (92%), raptors that were observed were believed to be actively migrating.

In addition to varying daily counts, the timing of raptor observations varied within each survey day. On average, raptor counts peaked between 10:00 and 11:00 am during the spring, and between 11:00 am and 12:00 pm during the fall (Figure 3-3; Appendix B, Tables 2a and 2b). Observations of raptors during the spring remained relatively consistent between 10:00 am and 4:00 pm, but during the fall observations declined steadily after 12:00 pm as the day progressed (Appendix B, Tables 2a and 2b).

During the spring, 95% of the observed raptors were flying less than 150 m agl and during the fall 93% of raptors were observed below 150 m agl (Appendix B, Tables 3a and 3b). Differences in flight altitudes between species were also observed (Figures 3-4a, 3-4b, 3-5a, and 3-5b). The mean flight altitude of turkey vultures was less than 39 m (128 ft); with 94% flying below 150 m. The mean flight altitude of red-tailed hawks was 38 m (125 ft), with 99% flying below 150 m.

Only four sandhill cranes were observed during the spring raptor survey, all seen on March 6, 2008. The first pair of cranes was observed between 2:00 and 3:00 pm flying at approximately 100 m (328 ft) agl at an azimuth of 50 degrees. The pair attempted to land in a nearby field, but then continued to fly through the Project area. The second pair of cranes was observed between 3:00 and 4:00 pm flying at approximately 200 m (656 ft) agl at an azimuth of 10 degrees.

[2] While turkey vultures are not true raptors, they are diurnal migrants that exhibit flight characteristics similar to hawks and other raptors and are typically included during hawk watch surveys.

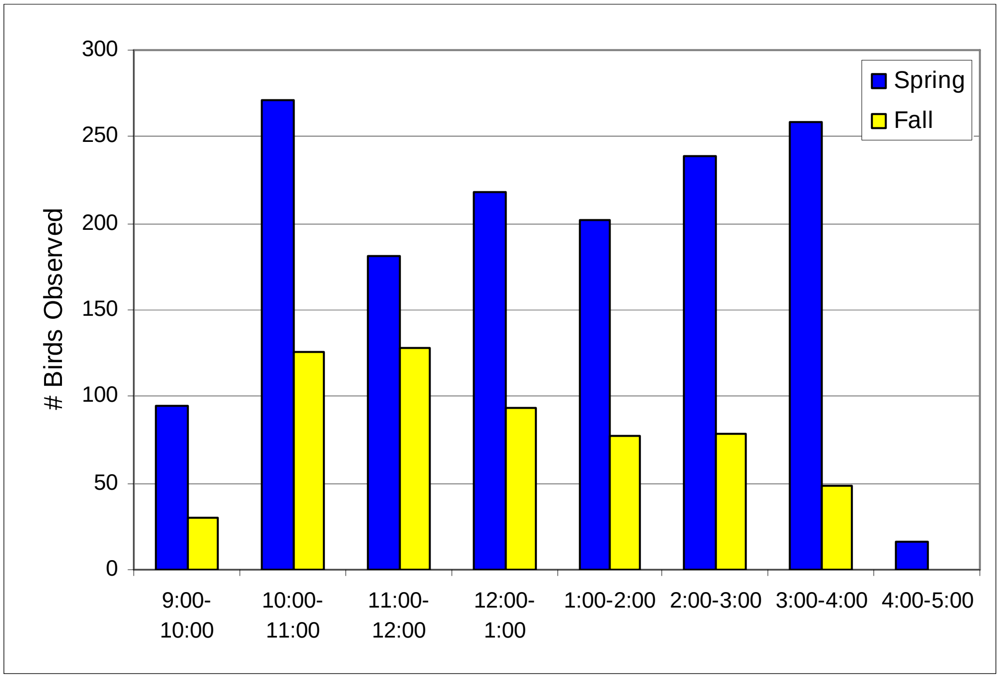


Figure 3-3. Hourly observation rates of raptors, fall 2007

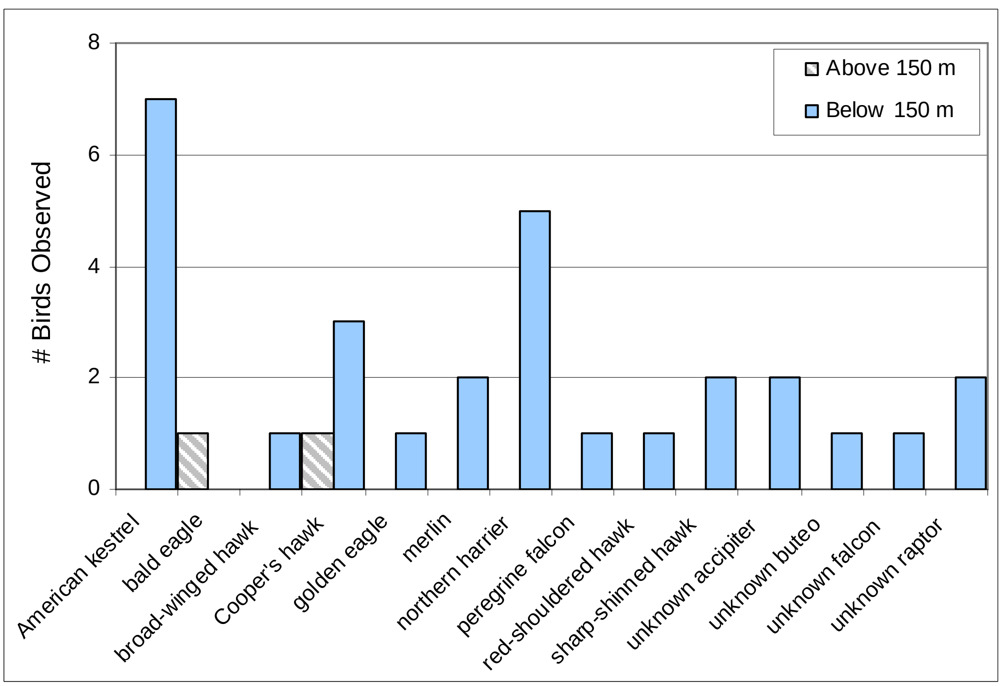


Figure 3-4a. Summary of flight altitudes and number of individuals for low-occurrence species observed above and below 150 m during spring 2008 raptor migration surveys

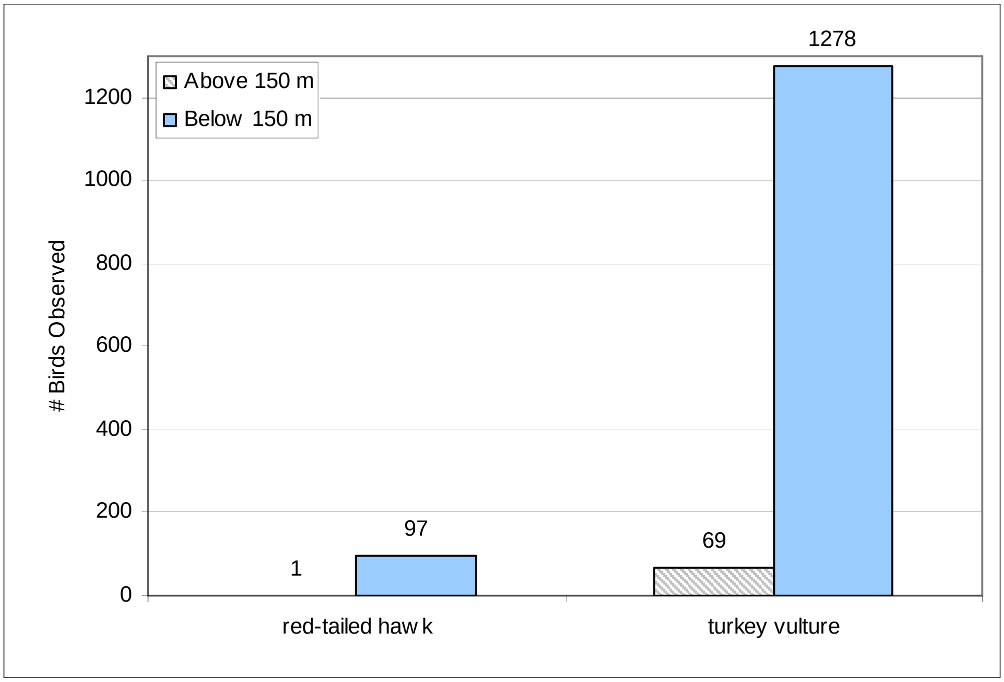


Figure 3-4b. Summary of flight altitudes and number of individuals for high-occurrence species observed above and below 150 m during spring 2008 raptor migration surveys

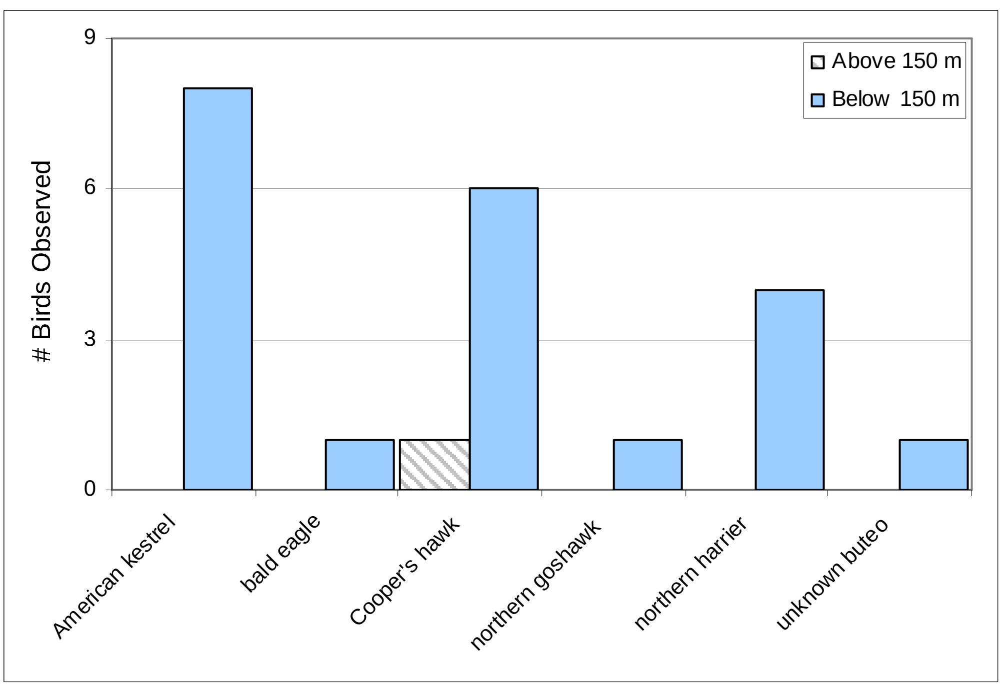


Figure 3-5a. Summary of flight altitudes and number of individuals for low-occurrence species observed above and below 150 m during fall 2008 raptor migration surveys

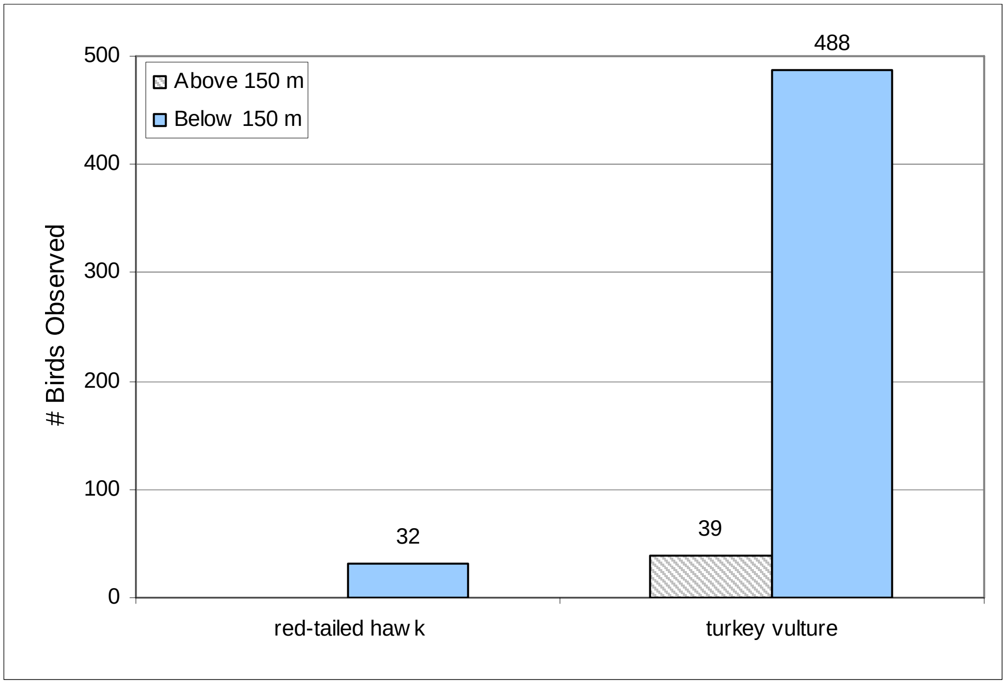


Figure 3-5b. Summary of flight altitudes and number of individuals for high-occurrence species observed above and below 150 m during fall 2008 raptor migration surveys

3.4 DISCUSSION AND CONCLUSIONS

During spring and fall 2008, a total of 2,084 individuals representing thirteen different species of raptors were observed during 68 days and 467 hours of observation, for a total observation rate of 4.5 birds/hour. Turkey vultures, considered one of the most common raptor species in the eastern United States (Wheeler 2003), accounted for 91% of all raptor observations and was the most commonly observed species during the survey. No federally threatened or endangered species were observed during the diurnal raptor surveys. Five northern harriers, a state-listed endangered species, were observed in the spring and four were observed in the fall. Four sandhill cranes, also a state endangered species, were observed in the spring. State threatened species observed included two bald eagles, one in the spring and one in the fall, and one peregrine falcon observed in the fall. Two sharp-shinned hawks, a state species of concern, were observed in the spring.

The overall number of raptors observed in the Project area was low relative to the numbers observed at other regional hawk watch sites. Observation rates at regional HMANA hawk watch sites ranged from 5.2 to 3082.8 birds/hour during fall 2007 (Appendix B, Table 4). The most active site was at Detroit River Hawkwatch (DRHW) Pointe Mouillee, Michigan, which is also the closest hawk watch site to the Project area (Site No. 5, Appendix B, Table 4). At DRHW, a total of 323,691 raptors were counted during 105 survey hours (3,082.8 birds/hour) during fall 2008. This was likely due to the close proximity of the site to Lake Erie, which is historically known to concentrate large numbers of raptors. The average passage rate of 4.5 birds/hour for the spring and fall raptor surveys in the Project area was lower than that for all other HMANA hawk watch sites in the region for which data were available during spring and fall 2008, despite having comparable or greater survey effort in most cases.

There are several reasons for the variations in numbers of raptors observed among hawk watch sites including survey effort, geographical location, weather, and visibility. Organized hawk count locations typically occur in areas of known concentrated raptor migration activity. Geographical location and topography can affect the magnitude of raptor migration at a particular site. Many of the regional hawk watch sites are located in areas of known concentrated raptor migration, such as those along the shores of the Great Lakes. The lower passage rate at the Project area is likely due to a lack of prominent landscape features that concentrate raptor migration.

When compared to 14 other publicly available spring raptor surveys conducted from 1999 to 2006 for wind projects, the passage rate observed for the Project (6.5 birds/hour) was similar to many in agricultural settings. The average passage rate for these sites was 5.2 birds/hr, with a range of 0.9 birds/hr at Deerfield, Vermont, to 25.6 birds/hr at Westfield, New York (Appendix B, Table 5). When compared to passage rates for 17 other fall surveys conducted from 1996 to 2007 for wind projects, the passage rate observed in the Project area (3.5 birds/hour) is among the lowest. Passage rates at other fall surveys averaged 4.4 birds/hour and ranged from a low of 3.0 raptors/hour in Clinton County, New York, to a high of 12.72 raptors /hour in Bennington County, Vermont (Appendix B, Table 6).

Flight heights of raptors observed in the Project area indicate that the majority of migrating raptors occur within the zone of the blade-swept area of the proposed turbines. This trend has also been observed at other proposed wind sites in the east, where the majority of raptors have been observed below the height of proposed turbines (Tables 3-1 and 3-2). Variation in flight heights is due to the particular flight behaviors of different raptor species, as well as daily weather conditions. Typically, accipiters and falcons use up-drafts from side slopes to gain lift and, therefore, usually fly low over ridgelines. Buteos tend to use lift from thermals that develop over side slopes and valleys and tend to fly high during hours of peak thermal development. Raptors (accipiters in particular) typically fly lower than usual during windy or inclement conditions.

The high percentage of low flight heights was likely influenced by the large number of observed turkey vultures which typically fly at lower heights than other migrants, as they are undertaking relatively small-scale movements while foraging. The frequent observation of turkey vultures relative to the other raptor species observed was notable but not unexpected. Turkey vultures have been known to historically occur in central Ohio in relatively high densities (Coles 1944) and regional hawk watch counts often have high numbers of turkey vulture observations (Appendix B, Table 4).

Although the greater occurrence of migrants at low altitudes increases the potential for migrating raptors to come into the vicinity of the proposed wind turbines, raptor mortality in the United States, outside of California, has been documented to be very low. For example, mortality rates found at onshore wind developments, outside of Altamont Pass in California, have documented 0 to 0.07 fatalities/turbine/year from 2000-2004 (GAO 2005). A more recent study at the Maple Ridge Wind Power facility in New York also documented very low raptor mortality. A single American kestrel was found during the 2006 study which surveyed 50 of 120 operational turbine sites (Jain *et al* 2007). The second year of monitoring at 64 of 195 turbines at Maple Ridge documented at total of 6 raptors (including those found incidentally and not during standard surveys): 1 sharp-shinned hawk and 5 red-tailed hawks (Jain *et al.* 2008). Raptors represented 6% (Jain *et al*. 2008) of the 96 total birds found during the second year of monitoring at Maple Ridge.

Out of more than a dozen sites surveyed in the U.S. in recent years, few had greater than 20 documented raptor fatalities (Osborn *et al*. 2000, Johnson *et al*. 2002, Kerlinger 2002, Young *et al*. 2003, Erickson *et al*. 2000, Kerlinger 2006, Erickson *et al*. 2002, Johnson *et al*. 2003, Kerns and Kerlinger 2004, Arnett *et al*. 2005, Koford *et al*. 2005, Fiedler *et al*. 2007, Jain *et al*. 2007, Jain *et al.* 2008). Studies have documented avoidance behaviors of raptors in response to turbines at modern wind facilities (Whitfield and Madders 2006, Chamberlain *et al.* 2006). Because most raptors are diurnal, they are likely able to visually, as well as acoustically, detect turbines during periods of fair weather, thereby reducing the chances of collision.

The results of the spring and fall 2008 surveys indicate that spring raptor migration at the proposed Project site is comparable or low relative to other sites in the region. The results of the 2008 survey indicates that raptors do not concentrate in large numbers through the Project area, probably because the site lacks the major topographical features that occur in other locations of the Central Continental Flyway which concentrate raptor activity. Only four sandhill cranes were observed incidentally during the spring raptor survey. The relatively low numbers of migrating raptors and sandhill cranes observed in the Project area decreases the potential risk of collision with the proposed turbines during migration.

4.0 Breeding Bird Survey

4.1 INTRODUCTION

Stantec conducted a breeding bird survey (BBS) during spring and summer 2008 to document the species composition, abundance, and distribution of breeding birds in the Project area.

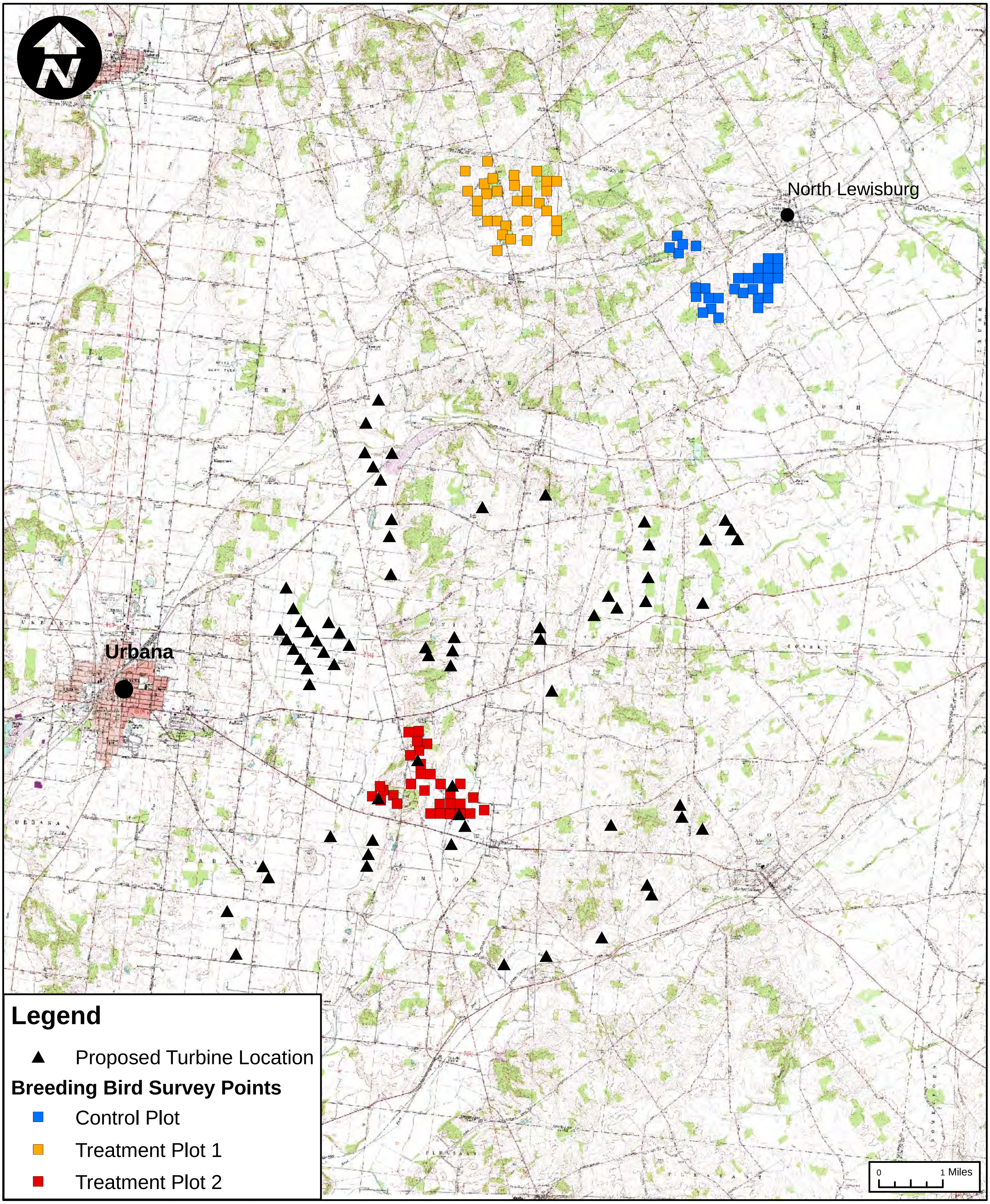
4.2 METHODS

4.2.1 Field Surveys

Stantec biologists conducted breeding bird surveys within the Project area once during May, twice in June, and once again in July 2008. Survey timing and methods were based on recommended protocol developed by the ODNR and modified from the USGS North American Breeding Bird Survey protocol as described by Sauer *et al.* (1997). Surveys focused on assessing the presence or absence of state or federally-listed species, but also documented all species of breeding birds either heard or visually detected within the Project area.

The point count method was used to count individuals of each species located at a series of survey points located in three survey grids positioned in the north, central, and southern portions of the Project area (Figure 4-1). Two sample plots were designed to survey breeding bird activity as close to the proposed turbines as possible, referred to as “treatment plots”. One sampling grid was designed to survey breeding bird activity that would not be affected by the development of the Project, and was referred to as the “control plot”. The control plot was positioned as far as possible from any proposed turbines, based on the best knowledge of long term project design. However, turbine locations are subject to change based on changing circumstances, such as land access and wind resources.

Each grid had a 10 x 10 configuration, with each cell 250 m by 250 m (820 ft by 820 ft) in size, and a sampling point located at or near the center of each cell. Thus, each grid was composed of 100 cells with 100 points, each a minimum of 250 m (820 ft) apart. The points were designed to sample available habitats in proportion to their availability. The ODNR specified in their recommended sampling protocol that no more than 20 points need be sampled in agricultural habitats, regardless of whether or not it comprised greater than 20% of the habitat in the sampling grid. The habitat in each of the sampling grids (and the larger Project area in general) consisted of approximately 10 to12% forested habitat, and 88 to 90% agricultural habitat. Thus, proportionally there were 10 to12 points sampled in forested habitat, and 18 to 20 points sampled in agricultural habitat in each sample grid. There was a total of 30 points sampled in each grid, for a total of 90 points sampled during the BBS. At least 25% of all points in each grid were placed at least 100 m from a roadway to minimize effects of roads and related disturbance on breeding birds.



Prepared By:

Stantec

Sheet Title:

Breeding Bird Survey Location Map

Project:

Buckeye Wind Power Project, Ohio

Date: February 2009

Scale: 1" = 2 Miles

Proj. No.: 195600164

Figure:

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Surveys were targeted to begin 30 minutes before sunrise and to be complete four hours after sunrise. Surveys were only conducted on days with suitably clear weather, with mild temperatures, and when rain or wind would not inhibit the detection of birds. GPS location, time, weather, habitat, species, number of individuals, and other behavioral notes were recorded during each point count. For each 10-minute point count, a 50 m (164 ft) radius circle around the observer was estimated and the area was divided into four quadrants. During the point count, the observers oriented themselves toward the north and plotted the location of each bird heard or seen within one of the four quadrants.

Each point count was broken into three time periods: the first three minutes, the following two minutes, and the final five minutes. For the duration of the 10-minute count surveys, the species and the number of individuals occurring between 0-50 m (0-164 ft), 50-100 m (164 – 328 ft), or greater than 100 m (328 ft) from the observer, or flying overhead, were recorded in the period during which they were first heard. During each consecutive time period, observers determined the location of previously recorded birds and tracked any movements within the count circle in order to avoid recounting birds. Other notes related to breeding behavior, weather conditions and habitat descriptions were recorded. When possible, observers made digital recordings of rare or unusual birds for purposes of documentation.

4.2.2 Data Analysis

Observational data collected during each round of point count surveys were used to determine species composition and distribution. Quantitative data collected during the second, third and fourth rounds of surveys were used to calculate the species richness (e.g., total number of species observed), relative abundance (e.g., evenness of species observed), and frequency of breeding birds within the available habitats of the project area. The control plot was analyzed separately from the treatment plots, and the surveyed habitats were summarized into two types: agricultural and forested. Data collected during the first survey round (May 1 -21) were not included in the statistical analysis due the large numbers of migrants included in point counts. Birds recorded as flyovers and greater than 100 m (328 ft) from the observer were also not included in statistical analyses; however these data were used to determine overall species richness and the total number of birds observed.

4.3 RESULTS

One round of surveys was conducted in May (May 3, 4, 6, 7, 9, 15, 20, and 21), one was conducted in June (June 1, 2, 4-7), one was conducted in both June and July (June 10-13, 24, 29 and July 7), and one was conducted in July (July 19, 20, 23-25, 27 and 29). Surveys were conducted when wind or rain conditions had no adverse effect on bird detection. Wind conditions during the surveys were predominantly calm to 5.4 m/s (12 mph); wind speeds did not exceed 10.7 m/s (24 mph) during the surveys. Weather conditions ranged from clear to overcast skies, although there were periods of fog during point count surveys on June 2 and June 13. Temperatures during the surveys ranged from 7 to 27º C (45º to 81º F).

A total of 90 breeding bird survey point counts were sampled during the site visits. A total of 5947 individual birds representing 97 species were observed during the point count surveys. The species most commonly observed among the 90 points included the red-winged blackbird (*Agelaius phoeniceus*) (n=1324), horned lark (*Eremophilia alpestris*) (n=427), American robin (*Turdus migratorius*) (n=304), song sparrow (*Melospiza melodia*) (n=297), American crow (*Corvus brachyrhynchos*) (n=246), and European starling (*Sturnus vulgaris)* (n=206) (Appendix C, Table 1).

The majority of birds (n=1996; 34%) were detected outside of the 100 m distance zone. Twenty-eight percent of birds (n=1663) were detected within the 50 to 100 m distance zone (Appendix C, Table 1). Birds that were detected outside of the 100 m zone or were observed flying overhead (n=1003; 17%) were not included in the species richness, abundance, or frequency analyses for each habitat due to the probability that they were not breeding within the 100 m circle. The habitat with the greatest species richness (SR) (SR=39) and relative abundance (RA) (RA=7.67) in the control plot was forested habitat (Appendix C, Table 2). The habitat with the greatest species richness (SR=47) and relative abundance (RA=9.22) in the treatment plots was agricultural habitat (Appendix C, Table 3).

In the control plot, 10 points were located in forested habitat and 20 points were located in agricultural habitat. SR among 10 points in forested habitat was 39. The species with the greatest relative abundances among these points included the indigo bunting (*Passerina cyanea*) (RA=0.90), American robin (RA=0.63), and song sparrow (RA=0.60). The species with the greatest frequency among forested points were the indigo bunting (Fr=100%), American robin (Fr=90%), blue jay (Fr=70%), downy woodpecker (*Picoides pubescens*) (Fr=70%) and song sparrow (Fr=70%) (Appendix C, Table 2). The twenty points in the control plot located in agricultural habitat had a SR score of 27. The species with the greatest relative abundances at the agricultural points in the control plot included the red-winged blackbird (RA=2.17), horned lark (RA=1.15), and song sparrow (RA=0.5). The species with the greatest frequency (Fr) among agricultural points were the red-winged blackbird (Fr=90%), horned lark (Fr=80%), and song sparrow (Fr=70%) (Appendix C, Table 2).

Between the two treatment plots, 37 points were located in agricultural habitat and 23 points were located in forested habitat. SR among these agricultural points was 47. The species that exhibited the greatest relative abundances in agricultural habitat were the red-winged blackbird (RA=3.95), horned lark (RA=0.87) and song sparrow (RA=0.70). The species with the greatest frequency among agricultural points were the song sparrow (Fr=81%), red-winged blackbird (Fr=70%) and horned lark (Fr=65%) (Appendix C, Table 3). The 23 points located in forested habitat in the in treatment plots had a SR score of 45. The species that demonstrated the greatest relative abundances among these points included the northern cardinal (*Cardinalis cardinalis*) (RA=0.78), American robin (RA=0.72), and house wren (*Troglodytes aedon*) (RA=0.39). The species with the greatest frequencies were also the American robin (Fr=100%), northern cardinal (Fr=96%), and house wren (RA=70%) (Appendix C, Table 3).

No federally endangered or threatened species were detected during the surveys. One state endangered species, the northern harrier, was detected, and one state threatened species, the least flycatcher (*Empidonax minimus*), was detected (ODNR 2007). Two state species of concern were also detected: the bobolink (*Dolichonyx oryzivorus*) and the northern bobwhite (*Colinus virginianus;* ODNR 2007). Two state species of special interest were also detected: the magnolia warbler (*Dendroica magnolia*) and the blackburnian warbler (*Dendroica fusca*; ODNR 2007).

4.4 DISCUSSION AND CONCLUSIONS

Breeding bird surveys documented a total of 97 species in the Project area. Surveys were conducted during the peak of the nesting season, in the morning when detection of birds is greatest, and during optimal weather conditions for detection. Therefore, it is likely that the species richness detected during surveys is a suitable reflection of the species composition of breeding birds in the area. However, certain species that make infrequent vocalizations, such as some species of woodpeckers, can be underrepresented during bird surveys (Farnsworth *et al.* 2002). It is also important to note that some surveys were conducted before and after the peak of the nesting season; therefore, it is possible that some birds detected during the earlier and later survey dates were not breeding in the Project area.

Species richness represents the total number of species observed, while relative abundance takes into account the evenness of the distribution of species. The control plot and the treatment plots differed in terms of the habitat types that yielded the highest species richness and relative abundance. In the control plot, points counts located in forested habitat yielded a higher value for species richness than points in agricultural habitat. Conversely, points counts located in agricultural habitat in the treatment plots had a higher value for species richness (although only slightly) than points in forested habitat. Species richness can be affected by a number of factors including proportion of forest cover, heterogeneity of habitat types, spatial arrangement of forest and agricultural patches (e.g., fragmentation), and proximity to riparian and wetland areas. Although a detailed habitat characterization was not included as part of this study, these factors may have influenced the different species richness and abundance values observed in different portions of the Project area.

Another important factor in understanding the species richness and relative abundance of birds in different habitat types is to consider the functional role of observed birds, or the ecological guild group to which they belong. For example, the higher species richness value in forested areas within the control plot was attributed to large numbers of common forest-dwelling species such as the indigo bunting, American robin, and blue jay. This was contrasted by large numbers of common field-dwelling species, such as red-winged blackbirds, horned larks, and song sparrows that were observed in agricultural areas in the treatment plots.

In general, the species observed in the Project area are common to the region and are typical of habitats in which they were observed. The exceptions to this were several birds detected during the first round of surveys in May (May 3 to 21), before the peak of the breeding season. A white-throated sparrow (*Zonotrichia albicollis*) was detected during this period, even though white-throated sparrows typically winter in the area and breed in more northern latitudes. A Louisiana waterthrush (*Seiurus motacilla*) was also detected during this period, however they are typically known to breed in riparian habitats and not the habitats sampled in the Project area. Several other birds detected during the first survey round are also suspected to be migrants based on their early observation dates and the fact that they were not observed during consecutive surveys. These include an Acadian flycatcher (*Empidonax virescens*), a least flycatcher, a black-throated green warbler (*Dendroica virens*), and a prairie warbler (*Dendroica discolor*).

5.0 Bat Hibernacula and Swarm Survey

5.1 INTRODUCTION

Hibernation is a physiological state undergone by many species of North American bats that reduces energy expenditure during the winter months when food (i.e., insects) is not available and when water availability is reduced. The length of hibernation in Ohio for many cave dwelling species, including Indiana bat, is roughly the period from mid October to mid April, with the exact timing influenced by insect availability and seasonal temperatures and weather conditions, among other things.

Stantec conducted a hibernacula survey in late winter (March 2008) and a swarm survey in fall 2008 to document the species composition and number of bats using Sanborn's Cave/Streng Cave (hereafter Sanborn's Cave) and one other unnamed cave in the Project area (Figure 5-1). In addition to these caves, 13 potential karst geological features identified in the Ohio Natural Heritage Database, maintained by the ODNR's Division of Natural Areas and Preserve (DNAP) were evaluated for use by bats. If any of these karst features were suspected to be suitable for use by bats, a fall swarm survey or winter hibernacula survey was to be subsequently completed.

5.2 METHODS

Stantec used the criteria established in the document "Bat Survey Protocol for Assessing Use of Potential Hibernacula" (USFWS 2008) to determine the suitability of potential hibernacula in the Project area. Potential hibernacula identified in the Project area were investigated in one of two ways: 1) if the potential hibernaculum was safely accessible by human beings, it was surveyed during the winter to document the presence/absence of hibernating bats of any species as well as species composition; or 2) if human access was not possible or safe, any area determined to be a potential hibernaculum was subject to a fall swarming survey to determine if bats of any species are using the area for swarming or hibernation. The timing and frequency of fall swarming surveys followed the protocol identified by the ODNR and took place once every two weeks from September 15 to November 15, 2008.

Fall swarming surveys were conducted using harp traps that were either 91 cm wide by a maximum of 112 cm tall (36 in X 44 in), or 183 cm wide by a maximum of 229 cm tall (72 in X 90 in), depending on the size of the cave opening. Harp traps were placed in the openings of caves and netting or plastic tarps were secured around the traps to close off as much of the flyway in and out of the cave as possible. During the first swarm survey on September 15, 2008, bats were also captured in 38 mm (1.5 in) diameter polyester mist-nets (Avinet, Inc., Dryden, NY) placed over the stream adjacent to the cave openings, to catch bats that were foraging over the stream. Mist-nets 9 m (30 ft) in width were vertically stacked up to three nets high (7.8 m [25.6 ft]) in order to more completely fill the flight corridor. Nets and harp traps were in place approximately 30 minutes before sunset and remained open for a minimum of five hours. In accordance with the USFWS protocol (2008), surveys were targeted to occurred on nights with temperatures greater than or equal to 10°C (50° F) for at least the first two hours of sampling, temperatures that remained above 1.7°C (35° F) for the first five hours of sampling, and were free of heavy rain for at least three hours of the survey period.

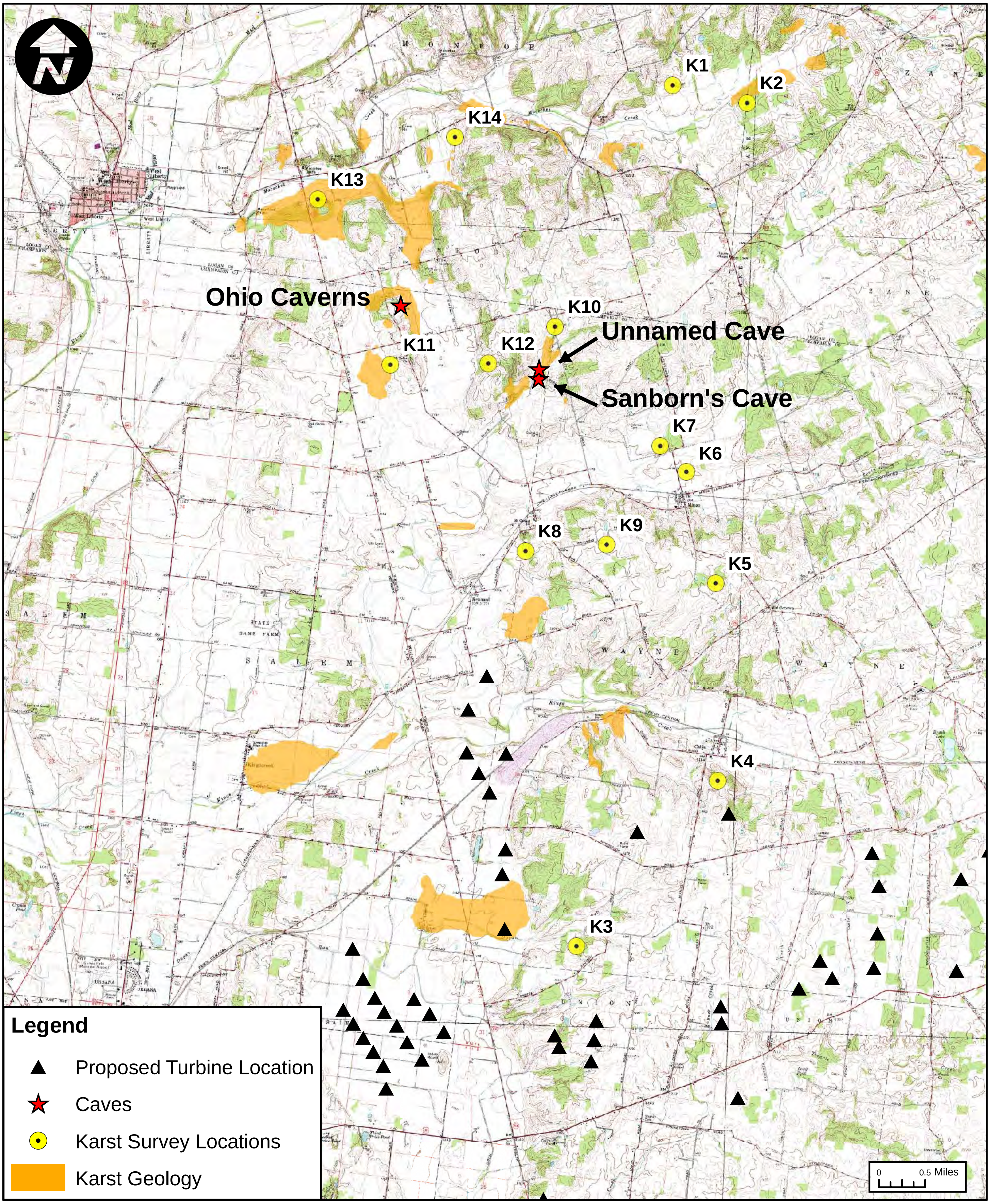
All bats captured during surveys were identified to species. If there was sufficient time to safely process bats as well as record additional information, the following data were recorded: age, sex, reproductive condition, and right forearm length. Because of concern regarding the potential spread of “white nose syndrome” (WNS), Stantec did not use any nets or holding bags from projects in those states, or any bordering states. Harps traps used were either new, or had never been used outside the Midwest. Additionally, Stantec followed mist-netting guidelines and bat handling procedures currently being developed by the USFWS for minimizing the spread of WNS. Swarming survey efforts were completed under Ohio Division of Wildlife Wild Animal Permit # 11-139, and Federal USFWS Permit #’s TE152002-1 and TE174547-0.

Documented and potential karst areas in the Project area identified by the ODNR DNAP were visited to determine if there were any openings in the ground that were indicative of the presence of a cave that could be used for hibernation by bats. An approximately 100 m (328 ft) area around the indicated feature on the map was searched for any potential openings, where landowner permission allowed. If any opening was discovered, a GPS location and physical description of the site was taken to identify and locate the opening for a subsequent swarming survey.

5.3 RESULTS

5.3.1 Karst Survey

A total of 10 of 14 potential karst features in the Project area documented by DNAP were visited to determine if the features had any openings that could be used by hibernating bats (Figure 5-1; Table 5-1). Only one of the 14 features was identified as being a “documented karst” by DNAP. This feature (K13 in Figure 5-1) was visited on March 3, 2008, and was found to have extensive exposed rock faces, but no openings were discovered. A total of ten additional features identified as being “faux karst” were visited on September 15, 2008. Table 5-1 lists each of these sites and provides a description of what was found during the survey.



Prepared By:

Stantec

Sheet Title:

Karst Survey Location Map

Project:

Buckeye Wind Power Project, Ohio

Date: *February 2009*

Scale: *1" = 1.1 Miles*

Proj. No.: *195600164*

Figure:

5-1

Table 5-1. Survey of potential and document karst features in the Project area

Karst ID	DNAP Description	Karst Survey Notes
K1	Faux Karst - pit or burrow	No evidence of karst features
K2	Faux Karst - glacial depression	No evidence of karst features
K3	Faux Karst???	There's a pond and a sink in an adjacent field; no openings
K4	Faux Karst	Not searched
K5	Faux Karst	Not searched
K6	Faux Karst	Large sink in field; no openings
K7	Faux Karst	Sink in field - gravel pit; no openings
K8	Faux Karst	Searched from road and saw no evidence of karst features
K9	Faux Karst	Searched from road and saw no evidence of karst features
K10	Documented Karst Feature	Old gravel pit; looks like something may have been filled in; no openings
K11	Faux Karst - Soils Spring	This is in the middle of an agricultural field; looks like just a depression; no openings
K12	Faux Karst - Soils Spring	Soil spring; no openings
K13	Karst Feature	Investigated March 08;extensive exposed rock faces, but no openings were discovered
K14	Faux Karst - glacial depression	Not searched

Three additional faux karst areas were not visited during the survey. This decision was made because the characterization of karst features by DNAP as being “faux” rather than “documented” was accurate, based on the 10 areas that were visited during the survey. It was therefore assumed that the remaining three features would also be faux karst areas and would not have any evidence of true karst topography or any openings that could be used by bats. In order to better utilize staff time and project resources, the remaining three faux karst features (K4, K5, and K14 in Figure 5-1) were not searched.

5.3.2 Hibernacula Survey

A hibernacula survey was conducted on March 4, 2008 at Sanborn’s Cave. Megan Seymour of the USFWS and Erin Hazleton of DNAP participated in the visit to Sanborn’s Cave. During the visit to Sanborn’s Cave, another nearby cave located approximately 150 m (492 ft) north of Sanborn’s Cave was brought to Stantec’s attention by a local landowner. Only a partial survey of Sanborn’s Cave and the nearby, unnamed cave were conducted due to landowner access restrictions or cave entry related safety issues. Only four tri-colored bats were observed on the ceiling of Sanborn’s Cave at the time of the partial survey. Biologists were not able to get far enough into the interior of the unnamed cave to document the presence of any hibernating bats. Consequently, due to safety issues and logistical constraints, a swarm survey was planned for both opening for the following fall.

5.3.3 Swarm Survey

A total of 884 bats were captured during five nights of swarm surveys that were conducted simultaneously at both cave openings on September 15 (365 bats captured), September 24 (168 bats captured), October 6 (244 bats captured), October 20 (99 bats captured), and October 27 (8 bats captured; Table 5-2). Temperatures remained above 7.2°C (45° F) for all nights surveys were conducted, except during the October 6 survey when the temperature dropped to 1.6°C (35° F) at approximately 11:00 pm and remained approximately at this temperature until the end of the survey at 12:30 am.

Table 5-2. Species captured at two cave locations in fall 2008 swarm surveys.

		Date						
Species	**Sex**	**9/15**	**9/24**	**10/6**	**10/20**	**10/27**	**Subtotals**	**Totals**
Big brown bat	Female	10					10	
	Male	2					2	12
Little brown bat	Female	20	12	5			37	
	Male	88	48	17	8	3	164	201
Northern long-eared bat	Female	109	60	63	16	2	250	
	Male	131	41	132	73	3	380	
	Unknown			22	1		23	653
Tri-colored bat	Female	2	3	3	1		9	
	Male	3	4	2			9	18
Total		365	168	244	99	8	884	

Three species were captured in harp traps: tri-colored bats, little brown bats, and northern long-eared bats (Table 5-2). Big brown bats were captured only in mist-nets placed over the stream during the first survey. The majority of bats were captured in the harp trap placed at the opening of the unnamed cave (n=704; 80%). Thirteen percent of bats (n=111) were captured in the harp trap placed at the opening of Sanborn's Cave and 6% of bats (n=52) were captured in mist-nets placed over a stream adjacent to Sanborn's Cave. Two percent (n=17) of bats were not identified as to whether they were captured in the unnamed cave, Sanborn's Cave, or in mist-nets due to rapid handling and processing of bats during peak swarming activity. Bats were marked with a temporary white paint on their wings to identify bats that were captured in traps or nets more than once, or recaptures. Twenty-four bats (3%) were recaptures from previous surveys or from an earlier time during the same survey night.

Northern long-eared bats were the most common species captured at the cave openings (74%; n= 653), with males representing 58% of all northern long-eared bats captured. The second most frequently captured species was the little brown bat, representing 23% (n= 201) of all bats captured. Males represented the majority (82%) of all little brown bats captured. The least frequently captured bats were tri-colored bats (n=18), followed by big brown bats (n=12).

5.4 DISCUSSION AND CONCLUSIONS

The species captured in the fall 2008 swarm surveys are bats that commonly hibernate in Ohio's caves during the winter. No state or federally listed bats, including the endangered Indiana bat, were captured in swarm surveys. The results of the swarm survey indicate that the two caves surveyed are used by swarming bats during the fall and probably provide suitable habitat for winter hibernation. However, the interpretation of swarm survey capture results is not always clear. Little is known about the behavior of bats during the spring and autumn migration period, and bats may visit and explore caves and mines during this period, but not hibernate in them during winter. Thus, it is not clear whether the bats captured in the fall 2008 swarm surveys are using these same caves for winter hibernation. However, the consistent capture of relatively high numbers of bats at these two caves throughout the fall swarming period and as late as October 6, and the relatively high total number of bats captured (n=884), strongly suggest that these caves provide suitable habitat for several species of bats for winter hibernation.

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Appendix A

Acoustic survey results

Appendix A Table 1. Summary of acoustic bat data and weather during each survey night at the North High detector – 2008

		BBSH			HB	MYSP	RBTP			UNKN					
Night of	Functional?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)
3/29/08	Y												0		
3/30/08	Y												0		
3/31/08	Y												0		
4/1/08	Y												0	5.7	0.8
4/2/08	Y												0	7.3	2.4
4/3/08	Y												0	8.0	8.6
4/4/08	Y												0	3.6	4.2
4/5/08	Y												0	7.4	6.8
4/6/08	Y												0	5.5	12.5
4/7/08	N													6.1	12.5
4/8/08	N													8.8	17.4
4/9/08	N													7.5	7.0
4/10/08	N													8.9	14.8
4/11/08	N													8.5	9.2
4/12/08	N													6.9	2.6
4/13/08	N													5.3	0.9
4/14/08	N													4.6	2.6
4/15/08	N													6.9	7.7
4/16/08	N													8.5	11.6
4/17/08	N													7.1	14.5
4/18/08	N													5.4	16.3
4/19/08	N													4.1	8.7
4/20/08	N													3.4	10.9
4/21/08	N													7.0	13.5
4/22/08	N													5.7	17.4
4/23/08	N													9.1	14.2
4/24/08	N													5.9	18.8
4/25/08	N													8.5	20.2
4/26/08	N													3.9	10.0
4/27/08	N													5.2	9.0
4/28/08	N													5.1	3.1
4/29/08	N													3.9	4.1
4/30/08	Y												0	6.7	11.3
5/1/08	Y	2	1										3	7.8	18.7
5/2/08	Y	1							1		1		3	9.5	16.4
5/3/08	Y												0	7.4	7.8
5/4/08	Y						1						1	4.8	11.4
5/5/08	Y			3			1				3		7	4.8	14.0
5/6/08	Y						1			1			2	6.5	17.1
5/7/08	Y												0	6.2	15.2
5/8/08	Y												0	7.4	9.4
5/9/08	Y												0	5.1	8.1
5/10/08	Y	3									1		4	6.7	12.1
5/11/08	Y									1			1	8.2	9.8
5/12/08	Y												0	4.6	8.2
5/13/08	Y												0	6.4	13.9
5/14/08	Y	1		1			1						3	5.4	12.1
5/15/08	Y												0	8.6	9.0
5/16/08	Y												0	6.7	11.6
5/17/08	Y										1		1	4.5	11.9
5/18/08	Y				1						1		2	5.4	6.6
5/19/08	Y												0	3.0	9.5
5/20/08	Y												0	5.5	8.1
5/21/08	Y												0	5.8	8.6
5/22/08	Y												0	4.8	11.0
5/23/08	Y												0	6.0	10.6
5/24/08	Y												0	4.6	10.4
5/25/08	Y				1								1	7.2	18.3
5/26/08	Y												0	6.3	19.2
5/27/08	Y									1			1	9.7	6.5
5/28/08	Y												0	6.4	9.9
5/29/08	Y												0	4.5	16.9
5/30/08	Y	2			1						2		5	9.2	20.9
5/31/08	Y										1		1	6.2	18.8
6/1/08	Y								1				1	5.8	17.5
6/2/08	Y	1									1		2	3.9	21.3
6/3/08	Y					1					1		2	5.4	20.5
6/4/08	Y				1						1		2	5.1	20.5
6/5/08	Y			1							2		3	7.3	25.8
6/6/08	Y		2								2		4	8.0	27.4
6/7/08	Y										1		1	4.7	24.1
6/8/08	Y						1				4		5	7.0	27.6
6/9/08	Y	1		1						1	2		5	6.7	26.5
6/10/08	Y	1											1	5.9	21.4
6/11/08	Y				1					1	4		6	4.9	23.5
6/12/08	Y												0	5.7	24.5
6/13/08	Y	2								1	1		4	6.3	24.1
6/14/08	Y	1											1	4.2	22.3
6/15/08	Y												0	5.1	22.6
6/16/08	Y										1		1	6.5	20.6
6/17/08	Y									1			1	6.2	16.4
6/18/08	Y												0	5.6	17.5
6/19/08	Y			3									3	4.0	18.2
6/20/08	Y									1	1		2	2.9	22.3
6/21/08	Y												0	5.4	20.1
6/22/08	Y	1									2		3	5.2	19.4
6/23/08	Y		1								2		3	4.8	18.8
6/24/08	Y	1	1	1			1						4	3.8	20.3
6/25/08	Y												0	5.4	21.9
6/26/08	Y										1		1	5.7	24.2
6/27/08	Y												0	4.8	23.6
6/28/08	Y										1		1	6.5	22.4
6/29/08	Y									1	1		2	7.1	21.2
6/30/08	Y									1			1	4.9	16.7
7/1/08	Y												0	3.8	19.4
7/2/08	Y	1									1		2	8.1	22.6
7/3/08	Y	2									1		3	6.3	19.7
7/4/08	Y				1								1	4.6	17.7
7/5/08	Y										1		1	4.8	20.6
7/6/08	Y		1		1						3		5	3.8	23.1
7/7/08	Y		2								2		4	4.3	24.5
7/8/08	N													6.5	23.5
7/9/08	N													6.2	22.5
7/10/08	N													3.7	21.9
7/11/08	N													5.5	24.3
7/12/08	N													6.8	23.4
7/13/08	N													6.3	21.9
7/14/08	N													4.3	20.5
7/15/08	Y										2		2	2.8	22.9
7/16/08	Y												0	3.8	24.9
7/17/08	Y												0	3.7	25.7
7/18/08	Y	1					1				1		3	5.1	25.8
7/19/08	Y		1								1		2	4.8	25.9
7/20/08	Y	2											2	6.8	25.3
7/21/08	Y	1								1	1		3	5.2	24.2
7/22/08	Y									1	2		3	4.7	22.5
7/23/08	Y										1		1	4.8	20.6
7/24/08	Y												0	4.3	20.9
7/25/08	Y	1								1	1		3	3.0	21.4
7/26/08	Y		1								2		3	4.7	22.9
7/27/08	Y												0	4.0	21.1
7/28/08	Y										2		2	3.8	22.4
7/29/08	Y						1				1		2	3.0	24.6
7/30/08	Y										4		4	5.9	23.8
7/31/08	Y	2								1			3	4.9	23.7
8/1/08	Y	2			2		1				1		6	5.1	24.3
8/2/08	Y	1	1								1		3	4.9	23.4
8/3/08	Y	1									2		3	2.9	22.2
8/4/08	Y	1									2		3	4.9	23.1
8/5/08	Y	2								1	3		6	6.2	22.5
8/6/08	Y	1									1		2	4.7	23.8
8/7/08	Y	1	1										2	5.5	20.9
8/8/08	Y	1									2		3	4.8	19.2
8/9/08	Y		1								1		2	4.8	19.6
8/10/08	Y												0	4.8	18.1
8/11/08	Y	1									1		2	4.0	18.5
8/12/08	Y								1		1		2	1.9	21.0
8/13/08	Y	2	1										3	3.5	21.3
8/14/08	Y									1			1	3.9	19.5
8/15/08	Y	1											1	4.5	20.1
8/16/08	Y										3		3	3.8	20.5
8/17/08	Y										2		2	4.5	20.4
8/18/08	Y	1								1			2	4.5	21.4
8/19/08	Y									2	3		5	5.0	22.7
8/20/08	Y		1								1		2	5.3	20.7
8/21/08	Y	1		1						1	6		9	5.8	24.0
8/22/08	Y		2				1			1	2		6	5.7	25.6
8/23/08	Y		1								2		3	4.6	25.7
8/24/08	Y	1	1				1			7	4		14	4.5	24.2
8/25/08	Y					1							1	8.2	20.0
8/26/08	Y										1		1	7.4	19.7
8/27/08	Y	2	2			2	1		1				8	5.4	19.3
8/28/08	Y	3								4			7	3.3	19.4
8/29/08	Y	2	1								1		4	4.6	23.8
8/30/08	Y									1	3		4	5.1	23.2
8/31/08	Y		1										1	5.9	22.8
9/1/08	Y	2	1				2		1	1	2	1	10	5.5	22.9
9/2/08	Y		1				1				1		3	4.5	26.2
9/3/08	Y		1	1						1	2		5	3.4	27.2
By Species		53	26	12	9	4	15	0	5	35	112	1	272		
By Guild		91			9	4	20			148					
		BBSH			HB	MYSP	RBTB			UNKN			Total		

Appendix A Table 2. Summary of acoustic bat data and weather during each survey night at the North Low detector – 2008

		BBSH			HB	MYSP	RBTP			UNKN					
Night of	**Functional?**	**BBSH**	**Big brown**	**Silver-haired**	**Hoary**	**MYSP**	**Eastern red**	**Tri-colored**	**RBTB**	**HFUN**	**LFUN**	**UNKN**	**Total**	**Wind Speed (m/s)**	**Temperature (celsius)**
03/29/08	Y												**0**		
03/30/08	Y												**0**		
03/31/08	Y												**0**		
04/01/08	Y												**0**	5.7	0.8
04/02/08	Y												**0**	7.3	2.4
04/03/08	Y												**0**	8.0	8.6
04/04/08	Y												**0**	3.6	4.2
04/05/08	Y												**0**	7.4	6.8
04/06/08	Y												**0**	5.5	12.5
04/07/08	N													6.1	12.5
04/08/08	N													8.8	17.4
04/09/08	N													7.5	7.0
04/10/08	N													8.9	14.8
04/11/08	N													8.5	9.2
04/12/08	N													6.9	2.6
04/13/08	N													5.3	0.9
04/14/08	N													4.6	2.6
04/15/08	N													6.9	7.7
04/16/08	N													8.5	11.6
04/17/08	N													7.1	14.5
04/18/08	N													5.4	16.3
04/19/08	N													4.1	8.7
04/20/08	N													3.4	10.9
04/21/08	N													7.0	13.5
04/22/08	N													5.7	17.4
04/23/08	N													9.1	14.2
04/24/08	N													5.9	18.8
04/25/08	N													8.5	20.2
04/26/08	N													3.9	10.0
04/27/08	N													5.2	9.0
04/28/08	N													5.1	3.1
04/29/08	N													3.9	4.1
04/30/08	Y	2								2	2		**6**	6.7	11.3
05/01/08	Y	2		1						1			**4**	7.8	18.7
05/02/08	Y	3			2		1						**6**	9.5	16.4
05/03/08	Y												**0**	7.4	7.8
05/04/08	Y								1		1		**2**	4.8	11.4
05/05/08	Y	3		2			1			2	4	1	**13**	4.8	14.0
05/06/08	Y		1						1	1	2		**5**	6.5	17.1
05/07/08	Y		1							1			**2**	6.2	15.2
05/08/08	Y												**0**	7.4	9.4
05/09/08	Y									1	1		**2**	5.1	8.1
05/10/08	Y	5		2		1				1	1		**10**	6.7	12.1
05/11/08	Y		1							1			**2**	8.2	9.8
05/12/08	Y												**0**	4.6	8.2
05/13/08	Y							1		1			**2**	6.4	13.9
05/14/08	Y		1			1	3			2	3		**10**	5.4	12.1
05/15/08	Y	1									1		**2**	8.6	9.0
05/16/08	Y	1					1			1	1		**4**	6.7	11.6
05/17/08	Y			1							1		**2**	4.5	11.9
05/18/08	Y					1	1						**2**	5.4	6.6
05/19/08	Y	1	1	1		1					1		**5**	3.0	9.5
05/20/08	Y									1	1		**2**	5.5	8.1
05/21/08	Y												**0**	5.8	8.6
05/22/08	Y			1			1						**2**	4.8	11.0
05/23/08	Y			1			1	1					**3**	6.0	10.6
05/24/08	Y	3	1										**4**	4.6	10.4
05/25/08	Y	2	1								2		**5**	7.2	18.3
05/26/08	Y	1				2	1		1	1	5		**11**	6.3	19.2
05/27/08	Y												**0**	9.7	6.5
05/28/08	Y				1					2			**3**	6.4	9.9
05/29/08	Y		2								1		**3**	4.5	16.9
05/30/08	Y	1								2	1		**4**	9.2	20.9
05/31/08	Y	2			1		1			1	3		**8**	6.2	18.8
06/01/08	Y	1							1	2	3		**7**	5.8	17.5
06/02/08	Y		1				2	1		1			**5**	3.9	21.3
06/03/08	Y	2											**2**	5.4	20.5
06/04/08	Y	2	2				1			1	1		**7**	5.1	20.5
06/05/08	Y	3	2	1	2		1			2	3		**14**	7.3	25.8
06/06/08	Y	3		1	1		2			2	4		**13**	8.0	27.4
06/07/08	Y	2	1					1	1	3	2		**10**	4.7	24.1
06/08/08	Y	3		1					1	1	2		**8**	7.0	27.6
06/09/08	Y	2	2	1	1		1		1	1	1		**10**	6.7	26.5
06/10/08	Y			1	1						4		**6**	5.9	21.4
06/11/08	Y	4	3		2		1			4	7		**21**	4.9	23.5
06/12/08	Y	3							1	2	1		**7**	5.7	24.5
06/13/08	Y		1							2	3		**6**	6.3	24.1
06/14/08	Y	2	3				1		1	1	2		**10**	4.2	22.3
06/15/08	Y	1	2										**3**	5.1	22.6
06/16/08	Y						2			1			**3**	6.5	20.6
06/17/08	Y	1					1			1	1		**4**	6.2	16.4
06/18/08	Y							1			2		**3**	5.6	17.5
06/19/08	Y	2	2	1						1	2		**8**	4.0	18.2
06/20/08	Y	4	2						1	1	1		**9**	2.9	22.3
06/21/08	Y	2									3		**5**	5.4	20.1
06/22/08	Y		1			1							**2**	5.2	19.4
06/23/08	Y	1	1						1	2			**5**	4.8	18.8
06/24/08	Y	1							1	3	3		**8**	3.8	20.3
06/25/08	Y		1								3		**4**	5.4	21.9
06/26/08	Y	2	3								9		**14**	5.7	24.2
06/27/08	Y		1								1		**2**	4.8	23.6
06/28/08	Y	1								2			**3**	6.5	22.4
06/29/08	Y		1				1		1	1		1	**5**	7.1	21.2
06/30/08	Y									1			**1**	4.9	16.7
07/01/08	N													3.8	19.4
07/02/08	N													8.1	22.6
07/03/08	N													6.3	19.7
07/04/08	N													4.6	17.7
07/05/08	N													4.8	20.6
07/06/08	N													3.8	23.1
07/07/08	N													4.3	24.5
07/08/08	Y	2	1								2		**5**	6.5	23.5
07/09/08	Y	4								1	1	1	**7**	6.2	22.5
07/10/08	Y	1	3								2		**6**	3.7	21.9
07/11/08	Y	1							1	1		1	**4**	5.5	24.3
07/12/08	Y		1								2		**3**	6.8	23.4
07/13/08	Y	1	2						1		4		**8**	6.3	21.9
07/14/08	Y	2	1								2		**5**	4.3	20.5
07/15/08	Y	4					1		1	3	4	1	**14**	2.8	22.9
07/16/08	Y	8	2			1	1		4	3	4		**23**	3.8	24.9
07/17/08	Y	8	2						2		7		**19**	3.7	25.7
07/18/08	Y	6				1	1		1	1	4		**14**	5.1	25.8
07/19/08	Y	8	3		1		4			3	4	1	**24**	4.8	25.9
07/20/08	Y	4	1		2	2	1		2	4	5	2	**23**	6.8	25.3
07/21/08	Y	5	3		1	1				4	8	1	**23**	5.2	24.2
07/22/08	Y	5					2		1	4	5	1	**18**	4.7	22.5
07/23/08	Y	1	2							3	1		**7**	4.8	20.6
07/24/08	Y	1	1				1		1	1	3		**8**	4.3	20.9
07/25/08	Y	4	1						1	1	7	1	**15**	3.0	21.4
07/26/08	Y	4	1				1			2	3		**11**	4.7	22.9
07/27/08	Y	8	2						2		1		**13**	4.0	21.1
07/28/08	Y	5	1				2			3	3		**14**	3.8	22.4
07/29/08	Y	7	3			1	2		2	4	5	2	**26**	3.0	24.6
07/30/08	Y	9	2			1	1			2	2		**17**	5.9	23.8
07/31/08	Y	5	1		1	1			1	3	9	1	**22**	4.9	23.7
08/01/08	Y	6	2				1		2	5	5	2	**23**	5.1	24.3
08/02/08	Y	4							2		3	2	**11**	4.9	23.4
08/03/08	Y	2	2			1	1			1	1	1	**9**	2.9	22.2
08/04/08	Y								1	1			**2**	4.9	23.1
08/05/08	Y	7	3				1			2	3	2	**18**	6.2	22.5
08/06/08	Y	2					1		2	3	4		**12**	4.7	23.8
08/07/08	Y	10	2							4	5		**21**	5.5	20.9
08/08/08	Y	3				1	1			1	2		**8**	4.8	19.2
08/09/08	Y	4									4		**8**	4.8	19.6
08/10/08	Y	3	3				1		1	6	6		**20**	4.8	18.1
08/11/08	Y	3					2			1	1		**7**	4.0	18.5
08/12/08	Y	6							2	2	3		**13**	1.9	21.0
08/13/08	Y	2							1	5	2		**10**	3.5	21.3
08/14/08	Y	1					1		1	4	4		**11**	3.9	19.5
08/15/08	Y	4	2				2		2	2	1		**13**	4.5	20.1
08/16/08	Y	3							1	1	4		**9**	3.8	20.5
08/17/08	Y	1	1						1	3	3	1	**10**	4.5	20.4
08/18/08	Y	6	2			1	3	1	3	8		1	**25**	4.5	21.4
08/19/08	Y	7	3				3		2	17	8	1	**41**	5.0	22.7
08/20/08	Y	4	4				1		4	6	5		**24**	5.3	20.7
08/21/08	Y	4	4				1		5	5	3		**22**	5.8	24.0
08/22/08	Y	2	5			1	1		2	5	5		**21**	5.7	25.6
08/23/08	Y	6	2		1					5	2		**16**	4.6	25.7
08/24/08	Y	9	3			1	5		4	15	6	3	**46**	4.5	24.2
08/25/08	Y	13	3				4		1	4	8	1	**34**	8.2	20.0
08/26/08	Y	7	2				4		1	1	6	1	**22**	7.4	19.7
08/27/08	Y	3	4			1	1		2	4	2		**17**	5.4	19.3
08/28/08	Y	10	6						1	3	10		**30**	3.3	19.4
08/29/08	Y	5					2		1	3	11	1	**23**	4.6	23.8
08/30/08	Y	8					4	1	1	2	2	2	**20**	5.1	23.2
08/31/08	Y	9	2				4		2	14	4		**35**	5.9	22.8
09/01/08	Y	4								2	5		**11**	5.5	22.9
09/02/08	Y	9	3							3	3		**18**	4.5	26.2
09/03/08	Y	8	4				3			12	10		**37**	3.4	27.2
By Species		**347**	**133**	**15**	**17**	**21**	**88**	**7**	**78**	**249**	**318**	**32**	**1305**		
By Guild		**495**			**17**	**21**	**173**			**599**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

Appendix A Table 3. Summary of acoustic bat data and weather during each survey night at the North Tree detector – 2008

		BBSH			HB	MYSP	RBTP			UNKN					
Night of	Functional?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)
3/29/08	Y												**0**		
3/30/08	Y												**0**		
3/31/08	Y												**0**		
4/1/08	Y												**0**	5.7	0.8
4/2/08	Y					1							**1**	7.3	2.4
4/3/08	Y												**0**	8.0	8.6
4/4/08	Y					1							**1**	3.6	4.2
4/5/08	Y	2	3							2			**7**	7.4	6.8
4/6/08	Y	1	1							1	2		**5**	5.5	12.5
4/7/08	N												**0**	6.1	12.5
4/8/08	N												**0**	8.8	17.4
4/9/08	N												**0**	7.5	7.0
4/10/08	N												**0**	8.9	14.8
4/11/08	N												**0**	8.5	9.2
4/12/08	N												**0**	6.9	2.6
4/13/08	N												**0**	5.3	0.9
4/14/08	N												**0**	4.6	2.6
4/15/08	N												**0**	6.9	7.7
4/16/08	N												**0**	8.5	11.6
4/17/08	N												**0**	7.1	14.5
4/18/08	N												**0**	5.4	16.3
4/19/08	N												**0**	4.1	8.7
4/20/08	N												**0**	3.4	10.9
4/21/08	N												**0**	7.0	13.5
4/22/08	N												**0**	5.7	17.4
4/23/08	N												**0**	9.1	14.2
4/24/08	N												**0**	5.9	18.8
4/25/08	N												**0**	8.5	20.2
4/26/08	N												**0**	3.9	10.0
4/27/08	N												**0**	5.2	9.0
4/28/08	N												**0**	5.1	3.1
4/29/08	N												**0**	3.9	4.1
4/30/08	N								1		2		**3**	6.7	11.3
5/1/08	Y	3	1						1	1	1		**7**	7.8	18.7
5/2/08	Y	1											**1**	9.5	16.4
5/3/08	Y					1			1	10	1		**13**	7.4	7.8
5/4/08	Y	2	2			1				2	2		**9**	4.8	11.4
5/5/08	Y	56	18	8		3			4	1	4		**94**	4.8	14.0
5/6/08	Y	6	1	1						1	1		**10**	6.5	17.1
5/7/08	Y	1											**1**	6.2	15.2
5/8/08	Y				1					4	5		**10**	7.4	9.4
5/9/08	Y	2				1				2	2		**7**	5.1	8.1
5/10/08	Y	7	2	1							4		**14**	6.7	12.1
5/11/08	Y	16	5							6			**27**	8.2	9.8
5/12/08	Y	7	3							1	2		**13**	4.6	8.2
5/13/08	Y	3							1				**4**	6.4	13.9
5/14/08	Y	23	12		1	1				12	18		**67**	5.4	12.1
5/15/08	Y	1			3				1	1			**6**	8.6	9.0
5/16/08	Y	11	13	1						1	8		**34**	6.7	11.6
5/17/08	Y	46	21	1					1	1	19		**89**	4.5	11.9
5/18/08	Y	3	2		2		1			2	1		**11**	5.4	6.6
5/19/08	Y	6	6		1						2		**15**	3.0	9.5
5/20/08	Y	4			17		6				1		**28**	5.5	8.1
5/21/08	Y	4	4		6					4	43		**61**	5.8	8.6
5/22/08	Y	4	4						2	3	2		**15**	4.8	11.0
5/23/08	Y	14	13						6		23		**56**	6.0	10.6
5/24/08	Y	37	23				1		2	3	29		**95**	4.6	10.4
5/25/08	Y	2									1		**3**	7.2	18.3
5/26/08	Y	37	6		3		10		1	11	10		**78**	6.3	19.2
5/27/08	N												**0**	9.7	6.5
5/28/08	N												**0**	6.4	9.9
5/29/08	N												**0**	4.5	16.9
5/30/08	N												**0**	9.2	20.9
5/31/08	N												**0**	6.2	18.8
6/1/08	N												**0**	5.8	17.5
6/2/08	Y	7									9		**16**	3.9	21.3
6/3/08	Y	11	2				6			9	1		**29**	5.4	20.5
6/4/08	Y	10	2			4			1	5			**22**	5.1	20.5
6/5/08	Y	3				1				3			**7**	7.3	25.8
6/6/08	Y	5								3	1		**9**	8.0	27.4
6/7/08	Y						3						**3**	4.7	24.1
6/8/08	Y	5								1			**6**	7.0	27.6
6/9/08	Y	87	4		1	2	1		1	13	23	1	**133**	6.7	26.5
6/10/08	Y	39	5				1			4	14	2	**65**	5.9	21.4
6/11/08	Y	16									2	2	**20**	4.9	23.5
6/12/08	Y	4									1	3	**8**	5.7	24.5
6/13/08	Y	9	1			1	46			32	2	1	**92**	6.3	24.1
6/14/08	Y	147	14	1		1				35	10	10	**218**	4.2	22.3
6/15/08	Y	46	87			2				1	5	13	**154**	5.1	22.6
6/16/08	Y	287	6							7	59	14	**373**	6.5	20.6
6/17/08	Y	37	10							8	2	6	**63**	6.2	16.4
6/18/08	Y	26								3	8		**37**	5.6	17.5
6/19/08	Y	57	11								45	4	**117**	4.0	18.2
6/20/08	Y	11	1						1	7	21	1	**42**	2.9	22.3
6/21/08	Y	6									4		**10**	5.4	20.1
6/22/08	Y	4								1	1		**6**	5.2	19.4
6/23/08	Y	53	13				1			1	15	2	**85**	4.8	18.8
6/24/08	Y	35	7							2	15	3	**62**	3.8	20.3
6/25/08	Y	173	84								73	68	**398**	5.4	21.9
6/26/08	Y	1									3		**4**	5.7	24.2
6/27/08	Y										1		**1**	4.8	23.6
6/28/08	Y												**0**	6.5	22.4
6/29/08	Y												**0**	7.1	21.2
6/30/08	Y												**0**	4.9	16.7
7/1/08	Y	26								2	1		**29**	3.8	19.4
7/2/08	Y	9	5								1		**15**	8.1	22.6
7/3/08	Y	27	2							4	6	1	**40**	6.3	19.7
7/4/08	Y	37	2						4	12	4		**59**	4.6	17.7
7/5/08	Y	57	1			1			1	4	11		**75**	4.8	20.6
7/6/08	Y	55	18			1				1	2	1	**78**	3.8	23.1
7/7/08	Y	4									5		**9**	4.3	24.5
7/8/08	Y	13	7		1	2	4			38		1	**66**	6.5	23.5
7/9/08	Y	103	2							3	11		**119**	6.2	22.5
7/10/08	Y	10					4			6			**20**	3.7	21.9
7/11/08	Y	6					2				1		**9**	5.5	24.3
7/12/08	Y	86	29		1	10	2			37	5	5	**175**	6.8	23.4
7/13/08	Y	240	26			3	3		1	17	26		**316**	6.3	21.9
7/14/08	Y	129	96				1		1	22	10		**259**	4.3	20.5
7/15/08	Y	20	3			1				4	2		**30**	2.8	22.9
7/16/08	Y	19	2			9	4			8	2		**44**	3.8	24.9
7/17/08	Y	14	3			1					2	1	**21**	3.7	25.7
7/18/08	Y	23	1			2			1	10	3		**40**	5.1	25.8
7/19/08	Y	16	2			39	3			28	5		**93**	4.8	25.9
7/20/08	Y	34	5			8	25		6	63	5		**146**	6.8	25.3
7/21/08	Y	367	28			24	9		6	49	30	4	**517**	5.2	24.2
7/22/08	N												**0**	4.7	22.5
7/23/08	N												**0**	4.8	20.6
7/24/08	N												**0**	4.3	20.9
7/25/08	N												**0**	3.0	21.4
7/26/08	N												**0**	4.7	22.9
7/27/08	N												**0**	4.0	21.1
7/28/08	N												**0**	3.8	22.4
7/29/08	N												**0**	3.0	24.6
7/30/08	Y	90	8			15	4		1	88	15	1	**222**	5.9	23.8
7/31/08	Y	176	9			15	1		1	66	60	3	**331**	4.9	23.7
8/1/08	Y	105	8		1	7	2		1	61	24	2	**211**	5.1	24.3
8/2/08	Y	130	17		2	17			8	60	9	1	**244**	4.9	23.4
8/3/08	Y	353	115			28	8		5	65	30	10	**614**	2.9	22.2
8/4/08	Y	27	4		4	6				16	4	1	**62**	4.9	23.1
8/5/08	Y	216	18			185	31		9	198	27	4	**688**	6.2	22.5
8/6/08	Y	69	13			31	4		2	120	12	3	**254**	4.7	23.8
8/7/08	N												**0**	5.5	20.9
8/8/08	N												**0**	4.8	19.2
8/9/08	N												**0**	4.8	19.6
8/10/08	N												**0**	4.8	18.1
8/11/08	N												**0**	4.0	18.5
8/12/08	N												**0**	1.9	21.0
8/13/08	N												**0**	3.5	21.3
8/14/08	N												**0**	3.9	19.5
8/15/08	N												**0**	4.5	20.1
8/16/08	N												**0**	3.8	20.5
8/17/08	N												**0**	4.5	20.4
8/18/08	Y	87	8				23		2	93	13	17	**243**	4.5	21.4
8/19/08	Y	19	6			1				5	3		**34**	5.0	22.7
8/20/08	Y	90	24			3	7		3	30	7	6	**170**	5.3	20.7
8/21/08	Y	26	4			6	2			6	7		**51**	5.8	24.0
8/22/08	Y	51	3			6	2		1	13	8	1	**85**	5.7	25.6
8/23/08	Y	95	10			10	1		2	19	15	3	**155**	4.6	25.7
8/24/08	Y	194	8			33	4		12	61	22		**334**	4.5	24.2
8/25/08	Y	34	4			13	2		3	15	10		**81**	8.2	20.0
8/26/08	Y	191	158			23			6	43	38		**459**	7.4	19.7
8/27/08	Y	45	3			8			4	39	1		**100**	5.4	19.3
8/28/08	Y										12		**12**	3.3	19.4
8/29/08	Y	187				1		1	2	12	23		**226**	4.6	23.8
8/30/08	Y	246	8							5	88	1	**348**	5.1	23.2
8/31/08	Y	253	14							3	91	1	**362**	5.9	22.8
9/1/08	Y	385	2			1				3	53		**444**	5.5	22.9
9/2/08	Y	459	2			2				23	86	3	**575**	4.5	26.2
9/3/08	14	608	4			14			2	30	24		**682**	3.4	27.2
By Species		**6809**	**1069**	**13**	**44**	**546**	**224**	**1**	**108**	**1586**	**1312**	**200**	**11912**		
By Guild		**7891**			**44**	**546**	**333**			**3098**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

Appendix A Table 4. Summary of acoustic bat data and weather during each survey night at the South High detector – 2008

		BBSH			HB	MYSP	RBTP			UNKN			Total	Wind Speed (m/s)	Temperature (celsius)
Night of	Functional?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN			
3/29/08	N														
3/30/08	N														
3/31/08	N														
4/1/08	N													5.7	0.8
4/2/08	N													7.3	2.4
4/3/08	N													8.0	8.6
4/4/08	N													3.6	4.2
4/5/08	N													7.4	6.8
4/6/08	N													5.5	12.5
4/7/08	N													6.1	12.5
4/8/08	N													8.8	17.4
4/9/08	Y												**0**	7.5	7.0
4/10/08	Y												**0**	8.9	14.8
4/11/08	Y												**0**	8.5	9.2
4/12/08	Y												**0**	6.9	2.6
4/13/08	Y												**0**	5.3	0.9
4/14/08	Y												**0**	4.6	2.6
4/15/08	Y												**0**	6.9	7.7
4/16/08	Y										1		**1**	8.5	11.6
4/17/08	Y	1											**1**	7.1	14.5
4/18/08	Y												**0**	5.4	16.3
4/19/08	Y												**0**	4.1	8.7
4/20/08	Y												**0**	3.4	10.9
4/21/08	N													7.0	13.5
4/22/08	N													5.7	17.4
4/23/08	N													9.1	14.2
4/24/08	N													5.9	18.8
4/25/08	N													8.5	20.2
4/26/08	N													3.9	10.0
4/27/08	N													5.2	9.0
4/28/08	N													5.1	3.1
4/29/08	N													3.9	4.1
4/30/08	N													6.7	11.3
5/1/08	N													7.8	18.7
5/2/08	N													9.5	16.4
5/3/08	N													7.4	7.8
5/4/08	N													4.8	11.4
5/5/08	N													4.8	14.0
5/6/08	N													6.5	17.1
5/7/08	N													6.2	15.2
5/8/08	N													7.4	9.4
5/9/08	N													5.1	8.1
5/10/08	N													6.7	12.1
5/11/08	N													8.2	9.8
5/12/08	N													4.6	8.2
5/13/08	N													6.4	13.9
5/14/08	N													5.4	12.1
5/15/08	Y												**0**	8.6	9.0
5/16/08	Y				1					1	1		**3**	6.7	11.6
5/17/08	Y	1									1		**2**	4.5	11.9
5/18/08	Y												**0**	5.4	6.6
5/19/08	Y										1		**1**	3.0	9.5
5/20/08	Y												**0**	5.5	8.1
5/21/08	Y												**0**	5.8	8.6
5/22/08	Y												**0**	4.8	11.0
5/23/08	Y												**0**	6.0	10.6
5/24/08	Y												**0**	4.6	10.4
5/25/08	Y				1		2						**3**	7.2	18.3
5/26/08	Y	1	1								3		**5**	6.3	19.2
5/27/08	Y												**0**	9.7	6.5
5/28/08	Y												**0**	6.4	9.9
5/29/08	Y						1						**1**	4.5	16.9
5/30/08	Y				2						1		**3**	9.2	20.9
5/31/08	Y	1					1				3		**5**	6.2	18.8
6/1/08	Y				1						3		**4**	5.8	17.5
6/2/08	Y	1	2							1	2		**6**	3.9	21.3
6/3/08	N													5.4	20.5
6/4/08	N													5.1	20.5
6/5/08	N													7.3	25.8
6/6/08	N													8.0	27.4
6/7/08	N													4.7	24.1
6/8/08	N													7.0	27.6
6/9/08	N													6.7	26.5
6/10/08	N													5.9	21.4
6/11/08	N													4.9	23.5
6/12/08	N													5.7	24.5
6/13/08	N													6.3	24.1
6/14/08	N													4.2	22.3
6/15/08	N													5.1	22.6
6/16/08	Y	2			1						1		**4**	6.5	20.6
6/17/08	Y									2			**2**	6.2	16.4
6/18/08	Y			1						1			**2**	5.6	17.5
6/19/08	Y										2		**2**	4.0	18.2
6/20/08	Y	2	1							1	1		**5**	2.9	22.3
6/21/08	Y										1		**1**	5.4	20.1
6/22/08	Y										2		**2**	5.2	19.4
6/23/08	Y										1		**1**	4.8	18.8
6/24/08	Y		1							1			**2**	3.8	20.3
6/25/08	Y			2							3		**5**	5.4	21.9
6/26/08	Y			2						1			**3**	5.7	24.2
6/27/08	Y										5		**5**	4.8	23.6
6/28/08	Y		2								1		**3**	6.5	22.4
6/29/08	Y									2	1		**3**	7.1	21.2
6/30/08	Y												**0**	4.9	16.7
7/1/08	Y				2					1			**3**	3.8	19.4
7/2/08	Y	1											**1**	8.1	22.6
7/3/08	Y												**0**	6.3	19.7
7/4/08	Y		1										**1**	4.6	17.7
7/5/08	Y										2		**2**	4.8	20.6
7/6/08	Y		1		1					1	2		**5**	3.8	23.1
7/7/08	Y	1			1						1		**3**	4.3	24.5
7/8/08	Y	1			1						1		**3**	6.5	23.5
7/9/08	Y				3						2		**5**	6.2	22.5
7/10/08	Y										1		**1**	3.7	21.9
7/11/08	Y				1	1					4		**6**	5.5	24.3
7/12/08	Y												**0**	6.8	23.4
7/13/08	Y									1	2		**3**	6.3	21.9
7/14/08	Y												**0**	4.3	20.5
7/15/08	Y		1		2					2	2		**7**	2.8	22.9
7/16/08	Y						1						**1**	3.8	24.9
7/17/08	Y						1			1	2		**4**	3.7	25.7
7/18/08	Y	1				1	1			1	2		**6**	5.1	25.8
7/19/08	Y										1		**1**	4.8	25.9
7/20/08	Y	3	3		2					1	5		**14**	6.8	25.3
7/21/08	Y	2			1						1		**4**	5.2	24.2
7/22/08	Y				1						1		**2**	4.7	22.5
7/23/08	Y									1			**1**	4.8	20.6
7/24/08	Y				1								**1**	4.3	20.9
7/25/08	Y	2									4		**6**	3.0	21.4
7/26/08	Y	1									3		**4**	4.7	22.9
7/27/08	Y				1						4		**5**	4.0	21.1
7/28/08	Y		3								3		**6**	3.8	22.4
7/29/08	Y	2								1	6		**9**	3.0	24.6
7/30/08	Y		2								6		**8**	5.9	23.8
7/31/08	Y	2	1								3		**6**	4.9	23.7
8/1/08	Y	1	2								4		**7**	5.1	24.3
8/2/08	Y	1	3								2		**6**	4.9	23.4
8/3/08	Y	2	1							1	1		**5**	2.9	22.2
8/4/08	Y	2	1								2		**5**	4.9	23.1
8/5/08	Y	1								1	3		**5**	6.2	22.5
8/6/08	Y	1	2								2		**5**	4.7	23.8
8/7/08	Y		1				1				4		**6**	5.5	20.9
8/8/08	Y											1	**1**	4.8	19.2
8/9/08	Y	3	1							1	3		**8**	4.8	19.6
8/10/08	Y		2							1	3		**6**	4.8	18.1
8/11/08	Y												**0**	4.0	18.5
8/12/08	Y									1	4		**5**	1.9	21.0
8/13/08	Y	1									1		**2**	3.5	21.3
8/14/08	Y	1					1				2		**4**	3.9	19.5
8/15/08	Y	1			1		1						**3**	4.5	20.1
8/16/08	Y		1								1		**2**	3.8	20.5
8/17/08	Y		2			1							**3**	4.5	20.4
8/18/08	Y		2							1	1		**4**	4.5	21.4
8/19/08	Y				1		1				3		**5**	5.0	22.7
8/20/08	Y		1							1	2		**4**	5.3	20.7
8/21/08	Y	6	1	1						1	5		**14**	5.8	24.0
8/22/08	Y	2	2				1			2	4		**11**	5.7	25.6
8/23/08	Y		1										**1**	4.6	25.7
8/24/08	Y	2					3		2	6	3		**16**	4.5	24.2
8/25/08	Y	2					2				1		**5**	8.2	20.0
8/26/08	Y	2	1		1				1		2		**7**	7.4	19.7
8/27/08	Y	1	1		2						2		**6**	5.4	19.3
8/28/08	Y		4	1						1	4		**10**	3.3	19.4
8/29/08	Y	2	1	2			1			1	3		**10**	4.6	23.8
8/30/08	Y						1						**1**	5.1	23.2
8/31/08	Y												**0**	5.9	22.8
9/1/08	Y	1	1		1						2		**5**	5.5	22.9
9/2/08	Y	3	1			1	1			3	2		**11**	4.5	26.2
9/3/08	Y						2			3	3		**8**	3.4	27.2
By Species		**60**	**51**	**9**	**29**	**4**	**22**	**0**	**3**	**44**	**161**	**1**	**384**		
By Guild		**120**			**29**	**4**	**25**			**206**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

Appendix A Table 5. Summary of acoustic bat data and weather during each survey night at the South Low detector – 2008

		BBSH			HB	MYSP	RBTP			UNKN					
Night of	Functional?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)
3/29/08	Y												**0**		
3/30/08	Y												**0**		
3/31/08	Y												**0**		
4/1/08	Y												**0**	5.7	0.8
4/2/08	Y												**0**	7.3	2.4
4/3/08	Y												**0**	8.0	8.6
4/4/08	Y												**0**	3.6	4.2
4/5/08	Y												**0**	7.4	6.8
4/6/08	Y	1					1				1		**3**	5.5	12.5
4/7/08	Y												**0**	6.1	12.5
4/8/08	Y												**0**	8.8	17.4
4/9/08	Y										1		**1**	7.5	7.0
4/10/08	Y												**0**	8.9	14.8
4/11/08	Y												**0**	8.5	9.2
4/12/08	Y												**0**	6.9	2.6
4/13/08	Y												**0**	5.3	0.9
4/14/08	Y												**0**	4.6	2.6
4/15/08	Y												**0**	6.9	7.7
4/16/08	Y	1									1		**2**	8.5	11.6
4/17/08	Y						1			1	1		**3**	7.1	14.5
4/18/08	Y	1	1		1		1			2			**6**	5.4	16.3
4/19/08	Y	1					1						**2**	4.1	8.7
4/20/08	Y										1		**1**	3.4	10.9
4/21/08	Y			2		1				1	2		**6**	7.0	13.5
4/22/08	Y	2	1								2		**5**	5.7	17.4
4/23/08	Y	3					1			1	2		**7**	9.1	14.2
4/24/08	Y	4									4		**8**	5.9	18.8
4/25/08	Y	2					1						**3**	8.5	20.2
4/26/08	Y	2	1						1		1		**5**	3.9	10.0
4/27/08	Y	2											**2**	5.2	9.0
4/28/08	Y												**0**	5.1	3.1
4/29/08	Y												**0**	3.9	4.1
4/30/08	Y	2					1		2	3	1		**9**	6.7	11.3
5/1/08	Y	2	1								3	1	**7**	7.8	18.7
5/2/08	Y						1						**1**	9.5	16.4
5/3/08	Y	1					1						**2**	7.4	7.8
5/4/08	Y	2								2	1		**5**	4.8	11.4
5/5/08	Y	2		1						2	1		**6**	4.8	14.0
5/6/08	Y		1								2		**3**	6.5	17.1
5/7/08	Y												**0**	6.2	15.2
5/8/08	Y	1		1									**2**	7.4	9.4
5/9/08	Y	1											**1**	5.1	8.1
5/10/08	Y	5	1							1	1		**8**	6.7	12.1
5/11/08	Y	1									1		**2**	8.2	9.8
5/12/08	Y	1											**1**	4.6	8.2
5/13/08	Y	2								2	1		**5**	6.4	13.9
5/14/08	Y	1								1			**2**	5.4	12.1
5/15/08	Y												**0**	8.6	9.0
5/16/08	Y										1		**1**	6.7	11.6
5/17/08	Y	2		1			1			1	4		**9**	4.5	11.9
5/18/08	Y									1			**1**	5.4	6.6
5/19/08	Y	1								1			**2**	3.0	9.5
5/20/08	Y												**0**	5.5	8.1
5/21/08	Y												**0**	5.8	8.6
5/22/08	Y												**0**	4.8	11.0
5/23/08	Y												**0**	6.0	10.6
5/24/08	Y	1									2		**3**	4.6	10.4
5/25/08	Y	1					1			1	4		**7**	7.2	18.3
5/26/08	Y		1		1	1							**3**	6.3	19.2
5/27/08	Y												**0**	9.7	6.5
5/28/08	Y									1			**1**	6.4	9.9
5/29/08	Y				1					2	2		**5**	4.5	16.9
5/30/08	Y				2						1		**3**	9.2	20.9
5/31/08	Y									1	3		**4**	6.2	18.8
6/1/08	Y						1				3		**4**	5.8	17.5
6/2/08	Y	2					1				2		**5**	3.9	21.3
6/3/08	Y	1	2		1		1			1	1		**7**	5.4	20.5
6/4/08	Y										4		**4**	5.1	20.5
6/5/08	Y		1							1	1		**3**	7.3	25.8
6/6/08	Y		1								2		**3**	8.0	27.4
6/7/08	Y	1	3							1	1		**6**	4.7	24.1
6/8/08	Y										1		**1**	7.0	27.6
6/9/08	Y	2	1				1			1	2		**7**	6.7	26.5
6/10/08	Y		1				1				1		**3**	5.9	21.4
6/11/08	Y	1								1	3		**5**	4.9	23.5
6/12/08	Y										6		**6**	5.7	24.5
6/13/08	Y										3		**3**	6.3	24.1
6/14/08	Y	2		1			1						**4**	4.2	22.3
6/15/08	Y		1								2		**3**	5.1	22.6
6/16/08	Y	1									4		**5**	6.5	20.6
6/17/08	Y										2		**2**	6.2	16.4
6/18/08	Y										1		**1**	5.6	17.5
6/19/08	Y				2					1	2		**5**	4.0	18.2
6/20/08	Y	4									1		**5**	2.9	22.3
6/21/08	Y	3	1								1		**5**	5.4	20.1
6/22/08	Y										1		**1**	5.2	19.4
6/23/08	Y									1	2		**3**	4.8	18.8
6/24/08	Y	2									4		**6**	3.8	20.3
6/25/08	Y	1											**1**	5.4	21.9
6/26/08	Y										2		**2**	5.7	24.2
6/27/08	Y									1	3		**4**	4.8	23.6
6/28/08	Y	2	1								2		**5**	6.5	22.4
6/29/08	Y												**0**	7.1	21.2
6/30/08	Y												**0**	4.9	16.7
7/1/08	Y												**0**	3.8	19.4
7/2/08	Y										1		**1**	8.1	22.6
7/3/08	Y									1			**1**	6.3	19.7
7/4/08	Y									1			**1**	4.6	17.7
7/5/08	Y										1		**1**	4.8	20.6
7/6/08	Y	1											**1**	3.8	23.1
7/7/08	Y			1						1			**2**	4.3	24.5
7/8/08	Y	1								1	2		**4**	6.5	23.5
7/9/08	Y	2	1										**3**	6.2	22.5
7/10/08	Y	1	2								1		**4**	3.7	21.9
7/11/08	Y		1		1					1	2		**5**	5.5	24.3
7/12/08	Y	1											**1**	6.8	23.4
7/13/08	Y	1											**1**	6.3	21.9
7/14/08	Y												**0**	4.3	20.5
7/15/08	Y	2					1				4		**7**	2.8	22.9
7/16/08	Y	1					1				3		**5**	3.8	24.9
7/17/08	Y	1									1		**2**	3.7	25.7
7/18/08	Y	2			3		1			4	1		**11**	5.1	25.8
7/19/08	Y	1			1				1	2	2		**7**	4.8	25.9
7/20/08	Y	2	3		2					1	4		**12**	6.8	25.3
7/21/08	Y	2								1	4		**7**	5.2	24.2
7/22/08	Y	1		1						1	6		**9**	4.7	22.5
7/23/08	Y												**0**	4.8	20.6
7/24/08	Y				1								**1**	4.3	20.9
7/25/08	Y	1	3				1			1	2		**8**	3.0	21.4
7/26/08	Y	3			1		1				6		**11**	4.7	22.9
7/27/08	Y	4	1								2		**7**	4.0	21.1
7/28/08	Y		3							1	2		**6**	3.8	22.4
7/29/08	Y	3	1	1			1				6		**12**	3.0	24.6
7/30/08	Y	3	4				1				7		**15**	5.9	23.8
7/31/08	Y	8			1		1			3	5		**18**	4.9	23.7
8/1/08	Y	6	5							1	10		**22**	5.1	24.3
8/2/08	Y	8					1				4		**13**	4.9	23.4
8/3/08	Y	1	1								3		**5**	2.9	22.2
8/4/08	Y	2	1		1		1			4	3		**12**	4.9	23.1
8/5/08	Y	13	1							2	6		**22**	6.2	22.5
8/6/08	Y	6	4				2				7		**19**	4.7	23.8
8/7/08	Y	3	1		1					1	10		**16**	5.5	20.9
8/8/08	Y	1					1						**2**	4.8	19.2
8/9/08	Y	6	4								4		**14**	4.8	19.6
8/10/08	Y	2	2			1	1			1	3		**10**	4.8	18.1
8/11/08	Y										1		**1**	4.0	18.5
8/12/08	Y		3								1		**4**	1.9	21.0
8/13/08	Y	1	3	1			1				4		**10**	3.5	21.3
8/14/08	Y	3	2				2				2		**9**	3.9	19.5
8/15/08	Y	2	1		1		1				2		**7**	4.5	20.1
8/16/08	Y	4	2				1				5		**12**	3.8	20.5
8/17/08	Y	2					2		1		1		**6**	4.5	20.4
8/18/08	Y	2	3				4			3			**12**	4.5	21.4
8/19/08	Y	5	3				2			1	6		**17**	5.0	22.7
8/20/08	Y	6	3	1	1		1			4	3		**19**	5.3	20.7
8/21/08	Y	12	5		1		5			2	8		**33**	5.8	24.0
8/22/08	Y	9	4		1	1	2			5	4		**26**	5.7	25.6
8/23/08	Y	2	3				1			1	1		**8**	4.6	25.7
8/24/08	Y	7	2	1			5			10	6		**31**	4.5	24.2
8/25/08	Y	6	1							1	8	1	**17**	8.2	20.0
8/26/08	Y	3					2			1	11	1	**18**	7.4	19.7
8/27/08	Y	1					1			1	2		**5**	5.4	19.3
8/28/08	Y	4	1							4	2		**11**	3.3	19.4
8/29/08	Y	2							1	1	8		**12**	4.6	23.8
8/30/08	Y										4		**4**	5.1	23.2
8/31/08	Y	1					1			1	1		**4**	5.9	22.8
9/1/08	Y	4					1			2	3		**10**	5.5	22.9
9/2/08	Y	4	2				1			1	3		**11**	4.5	26.2
9/3/08	Y									4	5		**9**	3.4	27.2
By Species		**236**	**95**	**12**	**24**	**4**	**64**	**0**	**6**	**102**	**304**	**3**	**850**		
By Guild		**343**			**24**	**4**	**70**			**409**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

Appendix A Table 6. Summary of acoustic bat data and weather during each survey night at the South Tree detector – 2008

		BBSH			HB	MYSP	RBTP			UNKN					
Night of	Functional?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)
03/29/08	N												0		
03/30/08	Y												0		
03/31/08	Y												0		
04/01/08	Y												0	5.7	0.8
04/02/08	Y												0	7.3	2.4
04/03/08	Y												0	8.0	8.6
04/04/08	Y												0	3.6	4.2
04/05/08	Y												0	7.4	6.8
04/06/08	Y	1									6		7	5.5	12.5
04/07/08	Y	1								1			2	6.1	12.5
04/08/08	Y										1		1	8.8	17.4
04/09/08	Y	2									3		5	7.5	7.0
04/10/08	Y									4			4	8.9	14.8
04/11/08	Y									1			1	8.5	9.2
04/12/08	Y												0	6.9	2.6
04/13/08	Y												0	5.3	0.9
04/14/08	Y												0	4.6	2.6
04/15/08	Y												0	6.9	7.7
04/16/08	Y												0	8.5	11.6
04/17/08	Y	1				1							2	7.1	14.5
04/18/08	Y	3									8		11	5.4	16.3
04/19/08	Y	1		1						1	2	1	6	4.1	8.7
04/20/08	Y	1		2						3	4		10	3.4	10.9
04/21/08	Y	10	2	2						1	15		30	7.0	13.5
04/22/08	Y	2	1			1				1	5		10	5.7	17.4
04/23/08	Y	57	18	1			1			9	20		106	9.1	14.2
04/24/08	Y	7								2	6		15	5.9	18.8
04/25/08	Y	2								1	5		8	8.5	20.2
04/26/08	Y	31	10	1						3	6		51	3.9	10.0
04/27/08	Y	31	3						1	3	7	1	46	5.2	9.0
04/28/08	Y	1											1	5.1	3.1
04/29/08	Y						4			5			9	3.9	4.1
04/30/08	Y	8	3			1				2	11	4	29	6.7	11.3
05/01/08	Y	17								1	6	1	25	7.8	18.7
05/02/08	Y	1									2		3	9.5	16.4
05/03/08	Y									1			1	7.4	7.8
05/04/08	Y	8	1								5		14	4.8	11.4
05/05/08	Y	120	17	37						3	26	1	204	4.8	14.0
05/06/08	Y	17								4	6	1	28	6.5	17.1
05/07/08	Y	1											1	6.2	15.2
05/08/08	Y	11				1				3			15	7.4	9.4
05/09/08	Y		1							8			9	5.1	8.1
05/10/08	Y	39	3								10		52	6.7	12.1
05/11/08	Y	20	6				3			18	1		48	8.2	9.8
05/12/08	Y	34	15								14	3	66	4.6	8.2
05/13/08	Y	16								1	14		31	6.4	13.9
05/14/08	Y	60	22				2			1	16	3	104	5.4	12.1
05/15/08	Y	1								1			2	8.6	9.0
05/16/08	Y	131	72				1			2	29	1	236	6.7	11.6
05/17/08	Y	117	33				2			2	40	1	195	4.5	11.9
05/18/08	Y	10	13										23	5.4	6.6
05/19/08	Y	3	1										4	3.0	9.5
05/20/08	Y	7	9								3		19	5.5	8.1
05/21/08	Y	38	36								12		86	5.8	8.6
05/22/08	Y	43	35				8			10	36	1	133	4.8	11.0
05/23/08	Y	50	5						2	7	21		85	6.0	10.6
05/24/08	Y	79	61	1			4		1	9	37	7	199	4.6	10.4
05/25/08	Y	15	6							1	24		46	7.2	18.3
05/26/08	Y	73	32			1	8			9	51	1	175	6.3	19.2
05/27/08	Y	1								1	1		3	9.7	6.5
05/28/08	Y	19	11		2		4			20	6	1	63	6.4	9.9
05/29/08	Y	33	13			1	5			1	18	3	74	4.5	16.9
05/30/08	Y	6	1		4		1			4	6		22	9.2	20.9
05/31/08	Y	253	51		4		22			24	123	3	480	6.2	18.8
06/01/08	Y	73	32		15		1		2	8	45	6	182	5.8	17.5
06/02/08	Y									1			1	3.9	21.3
06/03/08	Y												0	5.4	20.5
06/04/08	Y										4		4	5.1	20.5
06/05/08	Y												0	7.3	25.8
06/06/08	Y												0	8.0	27.4
06/07/08	Y	1											1	4.7	24.1
06/08/08	Y												0	7.0	27.6
06/09/08	Y	5								1	20	1	27	6.7	26.5
06/10/08	Y										2		2	5.9	21.4
06/11/08	Y	1								5			6	4.9	23.5
06/12/08	Y									1			1	5.7	24.5
06/13/08	Y										5		5	6.3	24.1
06/14/08	Y	1								1	8		10	4.2	22.3
06/15/08	Y	2				1					5	1	9	5.1	22.6
06/16/08	Y	2	1								6		9	6.5	20.6
06/17/08	Y	4									3		7	6.2	16.4
06/18/08	Y		1								2		3	5.6	17.5
06/19/08	Y	2	2							1	4		9	4.0	18.2
06/20/08	Y					1				1			2	2.9	22.3
06/21/08	Y	2									4		6	5.4	20.1
06/22/08	Y									1			1	5.2	19.4
06/23/08	Y	4	3								11		18	4.8	18.8
06/24/08	Y										5	1	6	3.8	20.3
06/25/08	Y	8	1								10		19	5.4	21.9
06/26/08	Y									1	1		2	5.7	24.2
06/27/08	Y												0	4.8	23.6
06/28/08	Y										4		4	6.5	22.4
06/29/08	Y										1	1	2	7.1	21.2
06/30/08	Y											1	1	4.9	16.7
07/01/08	Y										2		2	3.8	19.4
07/02/08	Y												0	8.1	22.6
07/03/08	Y										1	1	2	6.3	19.7
07/04/08	Y	1				1				1	1	1	5	4.6	17.7
07/05/08	Y		2							4	2	1	9	4.8	20.6
07/06/08	Y											1	1	3.8	23.1
07/07/08	Y												0	4.3	24.5
07/08/08	N												0	6.5	23.5
07/09/08	N												0	6.2	22.5
07/10/08	N												0	3.7	21.9
07/11/08	N												0	5.5	24.3
07/12/08	N												0	6.8	23.4
07/13/08	N												0	6.3	21.9
07/14/08	N												0	4.3	20.5
07/15/08	Y										2		2	2.8	22.9
07/16/08	Y									2			2	3.8	24.9
07/17/08	Y										1		1	3.7	25.7
07/18/08	Y	1								3	4		8	5.1	25.8
07/19/08	Y									1			1	4.8	25.9
07/20/08	Y	4								3	5		12	6.8	25.3
07/21/08	Y	17	1							2	29	2	51	5.2	24.2
07/22/08	Y	12				1				7	9		29	4.7	22.5
07/23/08	Y	28	12			1	1			11	21	2	76	4.8	20.6
07/24/08	Y	52	18				1			17	24	1	113	4.3	20.9
07/25/08	Y	2	2				1			4	5		14	3.0	21.4
07/26/08	Y	4				2	11			26	24	2	69	4.7	22.9
07/27/08	Y	18	1			1	1			10	12	2	45	4.0	21.1
07/28/08	Y	3	1				1		4	14	1		24	3.8	22.4
07/29/08	Y	3					1			9	2	2	17	3.0	24.6
07/30/08	Y										1		1	5.9	23.8
07/31/08	Y	2				2				5	5	1	15	4.9	23.7
08/01/08	Y									1	1	1	3	5.1	24.3
08/02/08	Y	1								5	1	2	9	4.9	23.4
08/03/08	Y	1								6	1	2	10	2.9	22.2
08/04/08	Y										1		1	4.9	23.1
08/05/08	Y	1	1							1	6	1	10	6.2	22.5
08/06/08	Y					1				1			2	4.7	23.8
08/07/08	Y	1				1			1	4	2		9	5.5	20.9
08/08/08	Y	1								3	3	2	9	4.8	19.2
08/09/08	Y									2	1		3	4.8	19.6
08/10/08	Y									3	11		14	4.8	18.1
08/11/08	Y	1								3	7	2	13	4.0	18.5
08/12/08	Y		1							7	3		11	1.9	21.0
08/13/08	Y									2			2	3.5	21.3
08/14/08	Y	1				1				1	1		4	3.9	19.5
08/15/08	Y									6	1	1	8	4.5	20.1
08/16/08	Y		1							1	4		6	3.8	20.5
08/17/08	Y		2							7	18	5	32	4.5	20.4
08/18/08	Y												0	4.5	21.4
08/19/08	Y												0	5.0	22.7
08/20/08	Y												0	5.3	20.7
08/21/08	Y												0	5.8	24.0
08/22/08	Y												0	5.7	25.6
08/23/08	Y												0	4.6	25.7
08/24/08	Y												0	4.5	24.2
08/25/08	Y					2				3		1	6	8.2	20.0
08/26/08	Y		1			1				5	3	2	12	7.4	19.7
08/27/08	Y	1				1				6	8		16	5.4	19.3
08/28/08	Y		1							4	2		7	3.3	19.4
08/29/08	Y	2							1	7	1		11	4.6	23.8
08/30/08	Y	5	2							6	10		23	5.1	23.2
08/31/08	Y	24	4						1	12	53	1	95	5.9	22.8
09/01/08	Y	4	3			1				8	8		24	5.5	22.9
09/02/08	Y									4	2		6	4.5	26.2
09/03/08	Y	2								7	1		10	3.4	27.2
By Species		**1679**	**574**	**45**	**25**	**24**	**83**	**0**	**13**	**423**	**1046**	**80**	**3992**		
By Guild		**2298**			**25**	**24**	**96**			**1549**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

Appendix B

Raptor survey results

Appendix B Table 1a. Summary of species observed on each day of raptor surveys in spring 2008

	Date																															
Species	**3/3**	**3/5**	**3/6**	**3/13**	**3/17**	**3/20**	**3/21**	**4/2**	**4/3**	**4/5**	**4/8**	**4/9**	**4/12**	**4/15**	**4/16**	**4/17**	**4/18**	**4/21**	**4/22**	**4/24**	**4/25**	**4/29**	**4/30**	**5/1**	**5/5**	**5/6**	**5/7**	**5/9**	**5/12**	**5/13**	**5/15**	**5/16**	**Total**
American kestrel								1	1	1					1									2	1								7
bald eagle									1																								1
broad-winged hawk				1																													1
Cooper's hawk							1								1							1				1							4
golden eagle																					1												1
merlin					1																						1						2
northern harrier					1								1								1				1	1							5
peregrine falcon															1																		1
red-shouldered hawk																	1																1
red-tailed hawk	1	2	2	4	5	5	4		5	3	2	3		6	3	5	2	3	4	1	3	1	5	2	5	3	1	2	4	6	4	2	98
sandhill crane			4																														4
sharp-shinned hawk				1																	1												2
turkey vulture	4		11	20	42	52	47	30	32	50	55	74	24	22	71	27	30	42	18	44	82	23	65	48	67	89	30	33	49	60	79	27	1347
unknown accipiter														2																			2
unknown buteo								1																									1
unknown falcon																			1														1
unknown raptor																							1						1				2
Total	5	2	17	26	49	57	52	32	39	54	57	77	25	30	77	32	33	45	23	45	88	25	71	52	74	94	32	35	54	66	83	29	1480

Appendix B Table 1b. Summary of species observed on each day of raptor surveys in fall 2008

	Date																							
Species	**9/1**	**9/2**	**9/3**	**9/11**	**9/18**	**9/23**	**9/25**	**9/26**	**10/10**	**10/12**	**10/13**	**10/14**	**10/21**	**10/22**	**10/23**	**10/27**	**10/29**	**10/30**	**11/2**	**11/3**	**11/4**	**11/11**	**11/12**	**11/13**	**Total**
American kestrel										1	2	2			1						1		1		8
bald eagle					1																				1
Cooper's hawk	3							1											1	1			1		7
northern goshawk		1																							1
northern harrier																1					2	1			4
red-tailed hawk	6	1	2		1	1			1		1	1	1	4	1	2	3	2	2	2				1	32
turkey vulture	23	23	32	21	14	23	15	20	31	18	20	18	54	77	38	14	23	37	6	7	6	2	3	2	527
unknown buteo																			1						1
Total	32	25	34	21	16	24	15	21	32	19	23	21	55	81	40	17	26	39	10	10	9	3	5	3	581

Appendix B Table 1c. Summary of species observed on each day of sandhill crane surveys in fall 2008

	Date												
Species	**11/17**	**11/18**	**11/19**	**11/23**	**11/24**	**11/25**	**12/4**	**12/5**	**12/6**	**12/7**	**12/8**	**12/9**	**Total**
American kestrel				1								1	2
Cooper's hawk				1									1
golden eagle				1									1
northern harrier			2	1									3
red-tailed hawk		1	1	2	1	1		1	1	1	1		10
turkey vulture	1	3					4	1		1			10
Total	1	4	3	6	1	1	4	2	1	2	1	1	27

Appendix B Table 2a. Observation totals of raptors and sandhill cranes by hour; spring 2008

Species	9:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00	3:00-4:00	4:00-5:00	Grand Total
American kestrel	1		1		2	1	2		7
bald eagle							1		1
broad-winged hawk						1			1
Cooper's hawk		1	1			1	1		4
golden eagle		1							1
merlin					1	1			2
northern harrier		1	2				2		5
peregrine flacon		1							1
red-shouldered hawk				1					1
red-tailed hawk	5	22	22	14	8	12	13	2	98
sharp-shinned hawk					2				2
turkey vulture	89	240	155	203	188	221	237	14	1347
unknown accipiter		2							2
unknown buteo					1				1
unknown falcon		1							1
unknown raptor		2							2
sandhill crane						2	2		4
Hourly totals:	95	271	181	218	202	239	258	16	1480

Appendix B Table 2b. Observation totals of raptors by hour; fall 2008

Species	9:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00	3:00-4:00	Grand Total
American kestrel	4	1	1		1	1		8
bald eagle	1							1
Cooper's hawk		1	3	2		1		7
golden eagle								0
northern goshawk					1			1
northern harrier	1				2		1	4
red-tailed hawk	4		10	7	4	3	4	32
turkey vulture	20	124	114	83	69	74	43	527
unknown buteo				1				1
Hourly totals:	30	126	128	93	77	79	48	581

Appendix B Table 3a. Raptor flight altitudes by species; spring 2008

Species	Less than 150 m	150 m or greater
American kestrel	7	
bald eagle		1
broad-winged hawk	1	
Cooper's hawk	3	1
golden eagle	1	
merlin	2	
northern harrier	5	
peregrine falcon	1	
red-shouldered hawk	1	
sharp-shinned hawk	2	
unknown accipiter	2	
unknown buteo	1	
unknown falcon	1	
unknown raptor	2	
red-tailed hawk	97	1
turkey vulture	1278	69
Totals:	1404	72

Appendix B Table 3b. Raptor flight altitudes by species; fall 2008

Species	Less than 150 m	150 m or greater
American kestrel	8	
bald eagle	1	
Cooper's hawk	6	1
northern goshawk	1	
northern harrier	4	
unknown buteo	1	
red-tailed hawk	32	
turkey vulture	488	39
Totals:	541	40

Appendix B Table 4. Summary of regional 2008 (February - December) migration surveys*to text

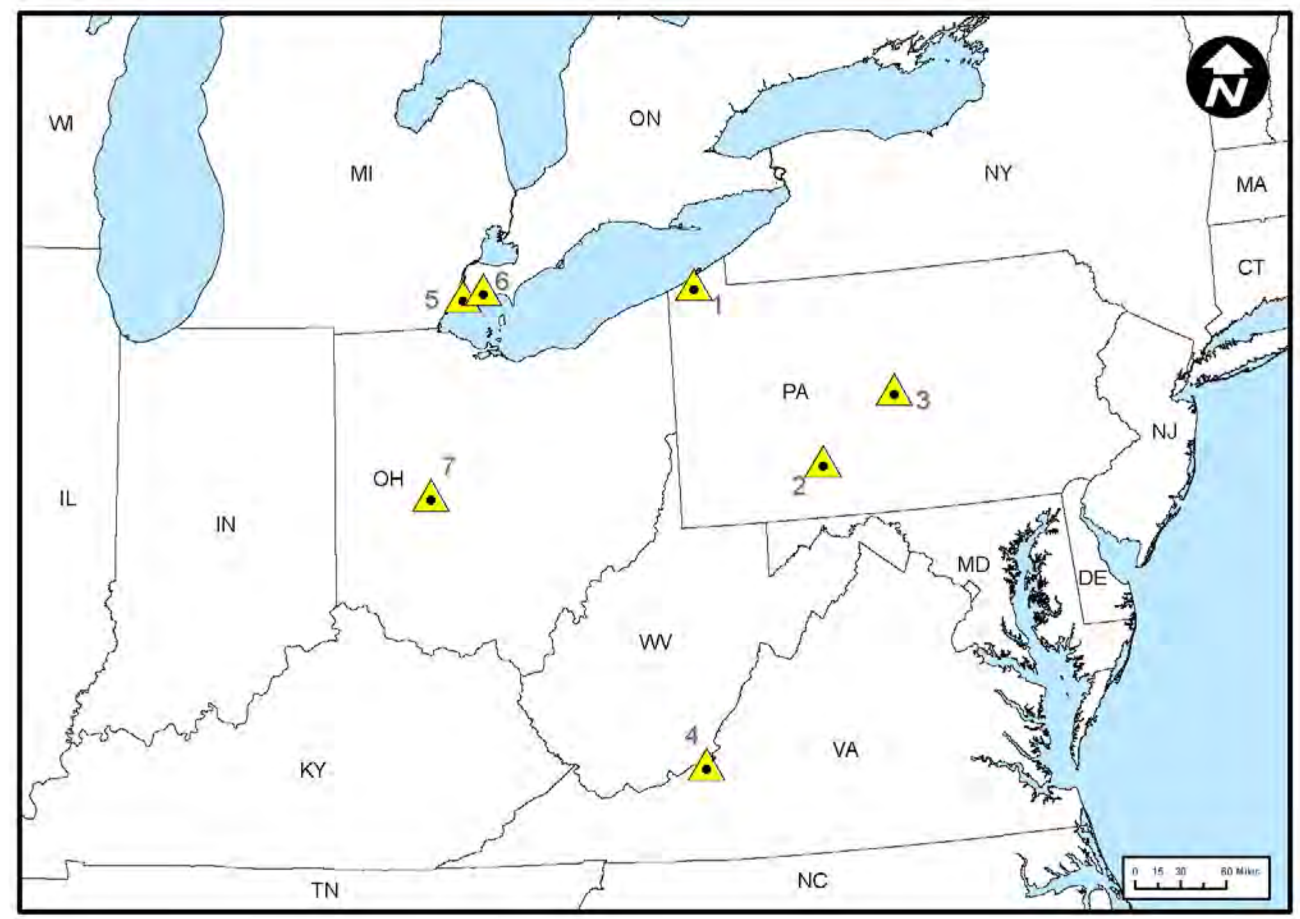
Site Number**	Season	Location	Site Characteristics	Observation Hours	BV	TV	OS	BE	NH	SS	CH	NG	RS	BW	RT	RL	GE	AK	ML	PG	UR	UB	UA	UF	UE	TOTAL	BIRDS/ HOUR
1	Spring	Presque Isle; Erie, PA	Bluff along south shore Lake Erie	35	0	1478	51	5	31	307	24	0	11	1661	205	8	0	139	7	1	4	3	1	0	0	3937	113
2	Spring and Fall	Allegheny Front; Central City,PA	High elevation forested ridge	1195	27	757	296	104	81	1171	250	16	166	4320	1762	5	248	81	33	19	51	79	8	5	167	9646	8
3	Spring	Tussey Mountain; State College, PA	Forested ridge	248	12	144	33	51	29	80	26	0	50	193	366	9	225	25	2	0	1	7	1	1	28	1283	5
4	Fall	Hanging Rock Tower; Waiteville, WV	Forested ridge	219	248	42	169	69	66	225	111	26	4	2268	286	366	14	279	25	6	2	15	9	2	3	2760	13
5	Fall	Detroit River Hawkwatch - Pointe Mouillee; Grosse Ile, MI	Peninsula on S side L. Erie	105	0	34503	11	54	143	1135	164	2	143	285546	1496	12	59	391	9	14	0	0	0	0	0	323691	3083
6	Fall	Holiday Beach; Amherstburg, ON	North side Lake Erie	424	0	21182	48	99	266	3533	219	7	298	8953	2282	23	133	597	36	30	1	11	0	0	1	37719	89
7	Spring and Fall	*Buckeye Mountain; Mingo, OH*	Agricultural plateau	467	0	1884	0	2	12	2	12	1	1	1	140	0	2	17	2	1	2	2	2	1	0	2084	4

* Data obtained from HMANA website (HMANA collects hawk count data from almost two hundred affiliated raptor monitoring sites throughout the United States, Canada, and Mexico). The HMANA count data used to construct this table included unusual species, such as Swainson's hawks and gyrfalcons. These numbers were not incorporated here.

** See map to right for site location.

Abbreviation Key:

BV - Black vulture
TV - Turkey vulture
OS - Osprey
BE - Bald eagle
NH - Northern harrier
SS - Sharp-shinned hawk
CH - Cooper's hawk
NG - Northern goshawk
RS - Red-shouldered hawk
BW - Broad-winged hawk
RT - Red-tailed hawk
RL - Rough-legged hawk
GE - Golden eagle
AK - American kestrel
ML - Merlin
PG – Peregrine falcon
UA – Unidentified accipiter
UB – Unidentified buteo
UF – Unidentified falcon
UE – Unidentified eagle
UR – Unidentified raptor



Appendix B Table 5. Summary of publicly available raptor survey results for wind projects

Year	Season	Project Site	State	Landscape	Survey Period	# Survey Days	# Survey Hours	# Birds Observed	# Species Observed	Passage Rate (b/hr)	% Below Turbine Height	Citation
1996	Fall	Searsburg, Bennington County	VT	Forested ridge	9/11-11/13	20	80	430	12	5.4	n/a	Kerlinger 1996
1998	Fall	Harrisburg, Lewis County	NY	Great Lakes plain	9/2-10/1	13	68	554	12	8.1	n/a (47 m mean flight height)	Cooper & Mabee 2000
1998	Fall	Wethersfield, Wyoming County	NY	Agricultural plateau	9/2-10/1	24	107	256	12	2.4	n/a (48 m mean flight height)	Cooper & Mabee 2000
2004	Fall	Prattsburgh, Steuben County	NY	Agricultural plateau	9/2-10/28	13	73	220	10	3.0	(125 m) 62%	Woodlot 2005b
2004	Fall	Cohocton, Steuben County	NY	Agricultural plateau	9/2-10/28	8	41	128	8	3.1	(125 m) 80%	ED&R 2006b
2004	Fall	Deerfield, Bennington County	VT	Forested ridge	9/2-10/31	10	60	147	11 for sites combined	2.5	(100 m) 9% for sites combined	Woodlot 2005c
2004	Fall	Deerfield, Bennington County	VT	Forested ridge	9/2-10/31	10	57	725	11 for sites combined	12.7	(100 m) 9% for sites combined	Woodlot 2005c
2004	Fall	Sheffield, Caledonia County	VT	Forested ridge	9/11-10/14	10	60	193	10	3.2	(125 m) 31%	Woodlot 2006a
2005	Fall	Cohocton, Steuben County	NY	Agricultural plateau	9/7-10/1	7	40	131	10	3.3	(125) 63%	ED&R 2006b
2005	Fall	Churubusco, Clinton County	NY	Great Lakes plain	10/6-10/22	10	60	217	15	3.6	(120 m) 69%	Woodlot 2005l
2005	Fall	Dairy Hills, Clinton County	NY	Great Lakes Shore	9/11-10/10	4	16	48	7	3.0	n/a	Young et al. 2006
2005	Fall	Howard, Steuben County	NY	Agricultural plateau	9/1-10/28	10	57	206	12	3.6	(91 m) 65%	Woodlot 2005o
2005	Fall	Munnsville, Madison County	NY	Agricultural plateau	9/6-10/31	11	65	369	14	5.7	(118 m) 51%	Woodlot 2005r
2005	Fall	Mars Hill, Aroostook County	ME	Forested ridge	9/9-10/13	8	43	115	13	1.5	(120 m) 42%	Woodlot 2005t
2005	Fall	Lempster, Sullivan County	NH	Forested ridge	Fall	10	80	264	10	3.3	(125 m) 40%	Woodlot 2007c
2005	Fall	Clayton, Jefferson County	NY	Agricultural plateau	9/9-10/16	11	64	575	13	9.1	(150 m) 89%	Woodlot 2005m
2006	Fall	Stetson, Penobscot County	ME	Forested ridge	9/14-10/26	7	42	86	11	2.1	(125 m) 63%	Woodlot 2007b
2007	Fall	Buckeye, Champaign and Logan Counties	OH	Agricultural plateau	8/30-10/11	11	66	421	8	6.4	(125) 78%; (150) 84%	*Not publicly available*
2008	Fall	Buckeye, Champaign and Logan Counties	OH	Agricultural plateau	9/1-12/15	24	167	581	7	3.5	(150 m) 93%	*this report*
1999	Spring	Wethersfield, Wyoming County	NY	Agricultural plateau	4/20-5/24	24	97	348	12	3.6	n/a (23 m mean flight height)	Cooper and Mabee 2000
2003	Spring	Westfield, Chautaugua	NY	Great Lakes shore	4/16-5/15	50	101	2578	17	25.6	n/a (278 m mean flight height)	Cooper et al.2004c
2005	Spring	Churubusco, Clinton County	NY	Great Lakes plain	Spring	10	60	170	11	2.8	(120 m) 69%	Woodlot 2005a
2005	Spring	Dairy Hills, Clinton County	NY	Great Lakes Shore	4/15-4/26	5	20	50	7	3.0	n/a	ED&R 2006b
2005	Spring	Clayton, Jefferson County	NY	Agricultural plateau	3/30-5/7	10	58	700	14	12.1	(150 m) 61%	Woodlot 2005b
2005	Spring	Prattsburgh, Steuben County	NY	Agricultural plateau	Spring	10	60	314	15	5.2	(125 m) 83%	Woodlot 2005u
2005	Spring	Cohocton, Steuben County	NY	Agricultural plateau	Spring	10	60	164	11	2.7	(125 m) 77%	ED&R 2006b
2005	Spring	Munnsville, Madison County	NY	Agricultural plateau	4/5-5/16	10	60	375	12	6.3	(118 m) 78%	Woodlot 2005d
2005	Spring	Sheffield, Caledonia County	VT	Forested ridge	April - May	10	60	98	10	1.6	(125 m) 69%	Woodlot 2006b
2005	Spring	Deerfield, Bennington County	VT	Forested ridge	4/9-4/29	7	42	44	11 (for both sites combined)	1.1	(125 m) 83% (at both sites combined)	Woodlot 2005g
2005	Spring	Deerfield, Bennington County	VT	Forested ridge	4/9-4/29	7	42	38	11 (for both sites combined)	0.9	(125 m) 83% (at both sites combined)	Woodlot 2005g
2006	Spring	Lempster, Sullivan County	NH	Forested ridge	Spring	10	78	102	n/a	1.3	125 m (18%)	Woodlot 2007c
2006	Spring	Howard, Steuben County	NY	Agricultural plateau	4/3-5/19	9	53	260	11	5.0	(125 m) 64%	Woodlot 2006d
2006	Spring	Mars Hill, Aroostook County	ME	Forested ridge	4/12-5/18	10	60	64	9	1.1	(120 m) 48%	Woodlot 2006g
2008	Spring	Buckeye, Champaign and Logan Counties	OH	Agricultural plateau	3/1-5/15	32	216	1476	12	6.8	(150 m) 95%	*this report*

Appendix C

Breeding bird survey results

Appendix C Table 1. Total number of species and individuals detected, and distance from observer at 90 point count locations during four survey periods - spring 2008*

Common name	Scientific name	0-50 m	50-100 m	> 100 m	Flyovers	Unknown	Grand Total
Acadian flycatcher	*Empidonax virescens*	1					1
American crow	*Corvus brachyrhynchos*	18	5	171	52		246
American goldfinch	*Carduelis tristis*	38	45	29	75	4	191
American kestrel	*Falco sparverius*				1		1
American redstart	*Setophaga ruticilla*	3	1				4
American robin	*Turdus migratorius*	71	90	114	29		304
Baltimore oriole	*Icterus galbula*	15	16	12			43
Barn swallow	*Hirundo rustica*	6	34	38	117		195
Black-and-white warbler	*Mniotilta varia*		2				2
Black-throated green warbler	*Dendroica virens*		1				1
Blackburnian warbler	*Dendroica fusca*	4					4
Blue-gray gnatcatcher	*Polioptila caerulea*	12	6				18
Blue-winged warbler	*Vermivora pinus*	2	1				3
Blue jay	*Cyanocitta cristata*	31	37	105	18		191
Bobolink	*Dolichonyx oryzivorus*	3	3	10			16
Brown-headed cowbird	*Molothrus ater*	61	45	27	27		160
Brown thrasher	*Toxostoma rufum*	7	13	13			33
Carolina chickadee	*Poecile carolinensis*	23	14	3			40
Carolina wren	*Thryothorus ludovicianus*	2	7	3			12
Canada goose	*Branta canadensis*	2		6	82		90
Cedar waxwing	*Bombycilla cedrorum*	2		3	23		28
Chestnut-sided warbler	*Dendroica pensylvanica*	3					3
Chimney swift	*Chaetura pelagica*		3	3	10		16
Chipping sparrow	*Spizella passerina*	6	10	29			45
Common grackle	*Quiscalus quiscula*	10	30	17	98		155
Common yellowthroat	*Geothlypis trichas*	18	26	34	1	1	80
Cooper's hawk	*Accipiter gentilis*		2		1		3
Downy woodpecker	*Picoides pubescens*	9	10	8	1		28
Eastern bluebird	*Sialia sialis*		1		1		2
Eastern kingbird	*Tyrannus tyrannus*	5	6	2	1		14
Eastern meadowlark	*Sturnella magna*	2	10	22	6		40
Eastern towhee	*Pipilo erythrophthalmus*	8	10	6			24
Eastern wood-pewee	*Contopus virens*	5	21	10			36
European starling	*Sturnus vulgaris*	45	24	106	31		206
Field sparrow	*Spizella pusilla*	7	50	104	1		162
Flycatcher sp.	*n/a*		1				1
Grasshopper sparrow	*Ammodramus savannarum*	6	3	1			10
Gray catbird	*Dumetella carolinensis*	44	20	7			71
Great blue heron	*Ardea herodias*				5		5
Great crested flycatcher	*Myiarchus crinitus*	7	15	16			38
Horned lark	*Eremophilia alpestris*	113	143	79	92		427
House finch	*Carpodacus mexicanus*	1					1
House sparrow	*Passer domesticus*	1	17	6			24
House wren	*Troglodytes aedon*	40	46	40			126
Indigo bunting	*Passerina cyanea*	59	62	60	5		186
Killdeer	*Charadrius vociferus*	20	18	88	20		146
Least flycatcher	*Empidonax minimus*	1					1
Louisiana waterthrush	*Seiurus motacilla*	1					1
Magnolia warbler	*Dendroica magnolia*	4					4
Mallard duck	*Anas platyrhynchos*			2	5		7
Merlin	*Falco columbarius*				1		1
Mourning dove	*Zenaida macroura*	13	27	62	56		158
Nashville warbler	*Vermivora ruficapilla*		2				2
Northern bobwhite	*Colinus virginianus*			2			2
Northern cardinal	*Cardinalis cardinalis*	38	60	58			156
Northern flicker	*Colaptes auratus*	2	3	11	1		17
Northern harrier	*Circus cyaneus*				1		1
Northern lapwing	*Vanellus vanellus*	1					1
Northern mockingbird	*Mimus polyglottos*	1			1		2
Northern parula	*Parula americana*		1	1			2
Northern rough-winged swallow	*Stelgidopteryx serripennis*				2		2
Orchard oriole	*Icterus spurius*	7	2	1			10
Ovenbird	*Seiurus aurocapillus*			1			1
Palm warbler	*Dendroica palmarum*	2	1				3
Prairie warbler	*Dendroica discolor*	1					1
Red-bellied woodpecker	*Melanerpes carolinus*	14	20	20			54
Red-eyed vireo	*Vireo olivaceus*	14	17	3			34
Red-headed woodpecker	*Melanerpes erythrocephalus*	4	1	4			9
Red-tailed hawk	*Buteo jamaicensis*	1		11	3		15
Red-winged blackbird	*Agelaius phoeniceus*	275	442	435	172		1324
Ring-necked pheasant	*Phasianus colchicus*			8			8
Rose-breasted grosbeak	*Pheucticus ludovicianus*	1	3	4			8
Rock pigeon	*Columba livia*	1		5	5		11
Ruby-throated hummingbird	*Archilochus colubris*			1	2		3
Savannah sparrow	*Passerculus sandwichensis*	8	17	7			32
Scarlet tanager	*Piranga olivacea*	4	3	1			8
Song sparrow	*Melospiza melodia*	89	116	90	2		297
Swamp sparrow	*Melospiza georgiana*					1	1
Tennessee warbler	*Vermivora peregrina*	3	1				4
Tree swallow	*Tachycineta bicolor*		2	1	21		24
Tufted titmouse	*Baeolophus bicolor*	11	24	25			60
Turkey vulture	*Cathartes aura*	1		14	31		46
Unidentified sp.	*n/a*	3	3				6
Vesper sparrow	*Pooecetes gramineus*	21	22	6			49
Warbling vireo	*Vireo gilvus*	4	2				6
White-breasted nuthatch	*Sitta carolinensis*	10	9	2			21
White-eyed vireo	*Vireo griseus*	3	1				4
White-throated sparrow	*Zonotrichia albicollis*	1					1
Willow flycatcher	*Empidonax traillii*	13	9	5			27
Wild turkey	*Meleagris gallopavo*			4			4
Wood duck	*Aix sponsa*		2		3		5
Wood thrush	*Hylocichla mustelina*	4	9	26			39
Woodpecker sp.	*n/a*	1		3			4
Yellow-billed cuckoo	*Coccyzus americanus*	2	8	5			15
Yellow-breasted chat	*Ictera virens*			1			1
Yellow-rumped warbler	*Dendroica coronata*	5	3				8
Yellow warbler	*Dendroica petechia*	5	5	5			15
Grand Total		1279	1663	1996	1003	6	5947

*Numbers largely represent singing males but also include male and some female individuals that were visually detected.

Appendix C Table 2. Total number of observations, relative abundance, and frequency of species at point count locations in the control plot during three survey periods; spring 2008

	Agricultural habitat (20 points)			Forest habitat (10 points)		
Species	**Total[a]**	**Relative abundance[b]**	**Frequency[c]**	**Total[a]**	**Relative abundance[b]**	**Frequency[c]**
American crow	1	0.02	5%		0.00	0%
American goldfinch	8	0.13	30%	10	0.33	40%
American robin	15	0.25	45%	19	0.63	90%
Baltimore oriole		0.00	0%	3	0.10	30%
Barn swallow	1	0.02	5%		0.00	0%
Blue-gray gnatcatcher		0.00	0%	3	0.10	20%
Blue jay	3	0.05	10%	15	0.50	70%
Brown-headed cowbird	7	0.12	25%	8	0.27	50%
Brown thrasher	2	0.03	10%	1	0.03	10%
Carolina chickadee		0.00	0%	12	0.40	50%
Carolina wren	2	0.03	10%		0.00	0%
Cedar waxwing	2	0.03	10%		0.00	0%
Chipping sparrow	4	0.07	15%		0.00	0%
Common grackle	6	0.10	10%	3	0.10	10%
Common yellowthroat	4	0.07	15%	7	0.23	40%
Downy woodpecker		0.00	0%	7	0.23	70%
Eastern kingbird	1	0.02	5%	3	0.10	20%
Eastern meadowlark		0.00	0%	1	0.03	10%
Eastern towhee		0.00	0%	4	0.13	40%
Eastern wood-pewee		0.00	0%	4	0.13	20%
European starling	2	0.03	5%	3	0.10	10%
Field sparrow	4	0.07	15%	4	0.13	40%
Gray catbird	2	0.03	10%	11	0.37	60%
Great crested flycatcher		0.00	0%	1	0.03	10%
Horned lark	69	1.15	80%	1	0.03	10%
House sparrow	5	0.08	5%		0.00	0%
House wren	6	0.10	15%	9	0.30	50%
Indigo bunting	11	0.18	30%	27	0.90	100%
Killdeer	9	0.15	30%	1	0.03	10%
Mourning dove	1	0.02	5%	4	0.13	40%
Northern cardinal	1	0.02	5%	8	0.27	50%
Northern flicker		0.00	0%	1	0.03	10%
Orchard oriole		0.00	0%	2	0.07	20%
Red-eyed vireo		0.00	0%	7	0.23	50%
Red-tailed hawk		0.00	0%	1	0.03	10%
Red-winged blackbird	130	2.17	90%	8	0.27	50%
Scarlet tanager		0.00	0%	2	0.07	20%
Song sparrow	30	0.50	70%	18	0.60	70%
Tufted titmouse		0.00	0%	9	0.30	60%
Vesper sparrow	27	0.45	50%	3	0.10	20%
White-breasted nuthatch		0.00	0%	2	0.07	10%
Willow flycatcher		0.00	0%	1	0.03	10%
Woodpecker sp.		0.00	0%	1	0.03	10%
Wood thrush		0.00	0%	1	0.03	10%
Yellow-billed cuckoo	1	0.02	5%	5	0.17	30%
Grand Total	**354**	**5.90**		**230**	**7.67**	
Species Richness	**27**			**39**		

a Total number of individuals detected (mainly singing males, also males and females that were visually observed).

b Mean number of birds observed.

c Percentage of survey points at which the species was observed.

Appendix C Table 3. Total number of observations, relative abundance, and frequency of species at point count locations in 2 treatment plots during three survey periods; spring 2008

	Agricultural habitat (37 points)			Forest habitat (23 points)		
Species	**Total[a]**	**Relative abundance[b]**	**Frequency[c]**	**Total[a]**	**Relative abundance[b]**	**Frequency[c]**
American crow	4	0.04	8%	17	0.25	17%
American goldfinch	20	0.18	32%	16	0.23	43%
American robin	39	0.35	46%	50	0.72	100%
Baltimore oriole	1	0.01	3%	6	0.09	22%
Barn swallow	32	0.29	8%		0.00	0%
Blue-gray gnatcatcher		0.00	0%	3	0.04	9%
Blue jay	5	0.05	8%	23	0.33	43%
Bobolink	1	0.01	3%		0.00	0%
Brown-headed cowbird	23	0.21	24%	15	0.22	39%
Brown thrasher	8	0.07	19%	6	0.09	17%
Carolina chickadee		0.00	0%	16	0.23	39%
Carolina wren	1	0.01	3%	6	0.09	26%
Chimney swift	3	0.03	3%		0.00	0%
Chipping sparrow	6	0.05	14%	1	0.01	4%
Common grackle	25	0.23	19%	1	0.01	4%
Common yellowthroat	15	0.14	30%	5	0.07	13%
Downy woodpecker	4	0.04	11%	4	0.06	13%
Eastern kingbird	4	0.04	5%	2	0.03	4%
Eastern meadowlark	6	0.05	16%		0.00	0%
Eastern towhee	2	0.02	5%	6	0.09	17%
Eastern wood-pewee		0.00	0%	19	0.28	52%
Eurpoean starling	9	0.08	8%	26	0.38	9%
Field sparrow	17	0.15	32%	12	0.17	30%
Flycatcher sp.		0.00	0%	1	0.01	4%
Grasshopper sparrow	7	0.06	14%		0.00	0%
Gray catbird	8	0.07	16%	23	0.33	57%
Great crested flycatcher	2	0.02	5%	15	0.22	43%
Horned lark	97	0.87	65%	1	0.01	4%
House finch	1	0.01	3%		0.00	0%
House sparrow	10	0.09	8%	1	0.01	4%
House wren	21	0.19	22%	27	0.39	70%
Indigo bunting	21	0.19	35%	25	0.36	65%
Killdeer	20	0.18	35%		0.00	0%
Mourning dove	15	0.14	16%	12	0.17	26%
Northern cardinal	18	0.16	30%	54	0.78	96%
Northern flicker	1	0.01	3%		0.00	0%
Northern lapwing		0.00	0%	1	0.01	4%
Northern parula		0.00	0%	1	0.01	4%
Orchard oriole	1	0.01	3%		0.00	0%
Red-bellied woodpecker	3	0.03	8%	17	0.25	48%
Red-eyed vireo		0.00	0%	15	0.22	30%
Red-headed woodpecker		0.00	0%	1	0.01	4%
Red-winged blackbird	438	3.95	70%	17	0.25	22%
Rock pigeon	1	0.01	3%		0.00	0%
Rose-breasted grosbeak		0.00	0%	4	0.06	13%
Savannah sparrow	21	0.19	24%		0.00	0%
Scarlet tanager		0.00	0%	2	0.03	9%
Song sparrow	78	0.70	81%	23	0.33	52%
Swamp sparrow		0.00	0%	1	0.01	4%
Tree swallow	2	0.02	3%		0.00	0%
Tufted titmouse	2	0.02	5%	16	0.23	43%
Turkey vulture	1	0.01	3%		0.00	0%
Unidentified sp.		0.00	0%	6	0.09	9%
Vesper sparrow	4	0.04	8%	3	0.04	9%
Warbling vireo	1	0.01	3%		0.00	0%
White-breasted nuthatch	2	0.02	5%	6	0.09	26%
White-eyed vireo		0.00	0%	3	0.04	9%
Willow flycatcher	20	0.18	24%		0.00	0%
Wood thrush		0.00	0%	5	0.07	17%
Yellow-billed cuckoo	1	0.01	3%	2	0.03	9%
Yellow warbler	2	0.02	5%		0.00	0%
Grand Total	**1023**	**9.22**		**516**	**7.48**	
Species Richness	**47**			**45**		

a Total number of individuals detected (mainly singing males, also males and females that were visually observed).

b Mean number of birds observed.

c Percentage of survey points at which the species was observed.